

Appendix B: SAMS Time Histories and Color Spectrograms

The Principal Investigator Microgravity Services (PIMS) group has further processed SAMS data from STS-79, Head C to produce the plots shown here. Three representations of the data are presented here: ten second interval average, ten second interval RMS, and PSD magnitude versus frequency versus time (spectrogram) plots. These calculations are presented in 6 hour plots, with the corresponding average and RMS plots on one page, and the spectrogram on the facing page.

The ten-second interval average plots give an indication of net accelerations which last for a period of 10 seconds or more. Shorter duration, high amplitude accelerations may be seen with this type of plot, however their exact timing and magnitude cannot be extracted. The ten-second interval RMS plots give a measure of the oscillatory content in the acceleration data. Plots of this type may be used to identify times when oscillatory and/or transient deviations from the background acceleration levels occurred.

Color spectrograms are used to show how the microgravity environment varies in intensity with respect to both the time and frequency domains. These spectrograms are provided as an overview of the frequency characteristics of the SAMS data during the mission. Each spectrogram is a composite of 6 hour's worth of data. The time resolution used to compute the spectrograms seen here is 65.536 seconds. This corresponds to a frequency resolution of 0.0153 Hz.

These data were collected at 125 samples per second, and a 25 Hz low pass filter was applied to the data by the SAMS unit prior to digitization. Prior to plot production, the raw SAMS data were compensated for gain changes, and then demeaned. Demeaning was accomplished by analyzing individual sections with a nominal length of 30 minutes. Users who are interested in further details for either of these operations are encouraged to contact the PIMS group.

Interval Average and Root Mean Square Calculations

The interval average plots were produced by calculating the average of ten second intervals of data for each axis. This operation is described as:

$$x_{avg_k} = \frac{1}{M} \sum_{i=1}^M x_{(k-1)M+i},$$

where x represents the x , y , or z axis data, M is the number of points analyzed in an interval, and k refers to the k th interval analyzed.

The resulting data streams (x_{avg_k} , y_{avg_k} , z_{avg_k}) are then combined by a vector-magnitude operation.

This computation is expressed mathematically as: $\text{accel}_{\text{avg}_k} = \sqrt{x_{\text{avg}_k}^2 + y_{\text{avg}_k}^2 + z_{\text{avg}_k}^2}$.

The interval RMS plots were produced by taking the root-mean-square of ten second intervals of data for each axis and forming a vector magnitude of the resulting data stream.

The interval RMS operation is expressed mathematically as: $x_{\text{RMS}_k} = \sqrt{\frac{1}{M} \sum_{i=1}^M (x_{(k-1)M+i})^2}$.

The same definitions apply for x, M, and k as in the interval average computation. The resulting data streams are combined by a vector-magnitude operation.

Power Spectral Density versus Frequency versus Time Calculations

In order to produce the spectrogram image, Power Spectral Densities were computed for successive time intervals (the length of the interval is equal to the time resolution). For the PSD computation, a Hanning window was applied. In order to combine all three axes into a single plot to show an overall level, a Vector-Magnitude (VM) operation was performed. Stated mathematically:

$$\text{VM}_k = \sqrt{\text{PSD}_{x_k}^2 + \text{PSD}_{y_k}^2 + \text{PSD}_{z_k}^2}.$$

By imaging the base 10 logarithm (\log_{10}) magnitude as a color and stacking successive PSDs from left to right, variations of acceleration magnitude and frequency are shown as a function of time. Colors are assigned to discrete magnitude ranges, so that there are 64 colors assigned to the entire range of magnitudes shown.

The colorbar limits are chosen in order to maximize the data value and visibility in a given set of spectrogram plots. Data which fall outside of these limits will be imaged as either the highest or lowest magnitude, depending on which side they have saturated. For this report, less than 1% of the total points lie below the lower limit, and less than 1% of the total points lie above the upper limit. If an area of interest seems to be saturated, care should be taken in that the actual values may lie above or below the color mapping shown on the plot.

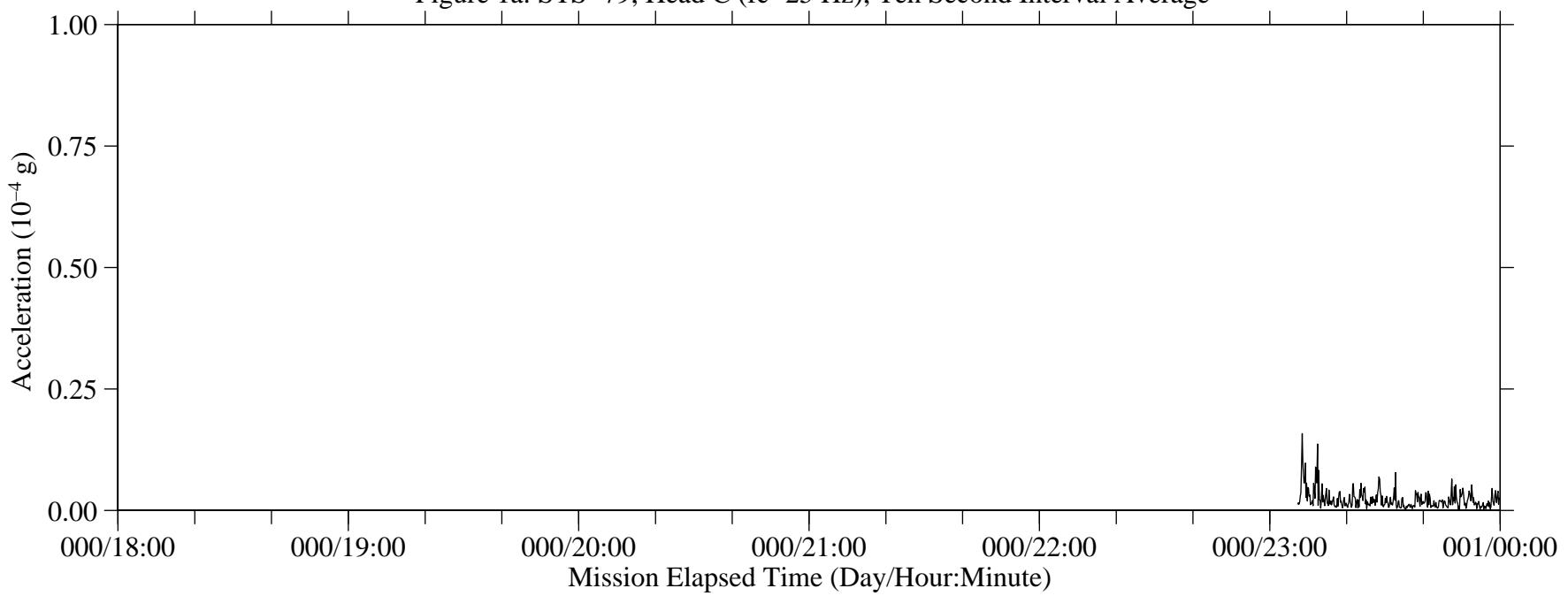
Due to the nature of spectrograms, care should be taken to not merely read a color's numeric value as being the "amount" of acceleration that is present at a given frequency. In order to get this type of information, the PSDs must be integrated between two frequencies. These frequencies (lower and upper) form the "band" of interest. The result of this integration is the g_{RMS} acceleration level in the $[f_{\text{lower}}, f_{\text{upper}}]$ band. The PIMS group is able to provide this type of analysis on a per-request basis.

Plot gaps (if any exist) are shown by either white or dark blue areas on the page. Care should be taken to not mistake a plot gap (represented by a blue vertical band) with a quiet period. If a plot gap exists for an entire plot (or series of successive plots), a comment is placed on the page to let the user know there is a gap in the data. These “no data available” comments will not show exact times for which the data are not available, but will only indicate missing plots.

Contacting PIMS

To request additional analysis or information, users are encouraged to send an e-mail to pims@lerc.nasa.gov, or FAX a request to (216) 433-8545.

Figure 1a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-4

Figure 1b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

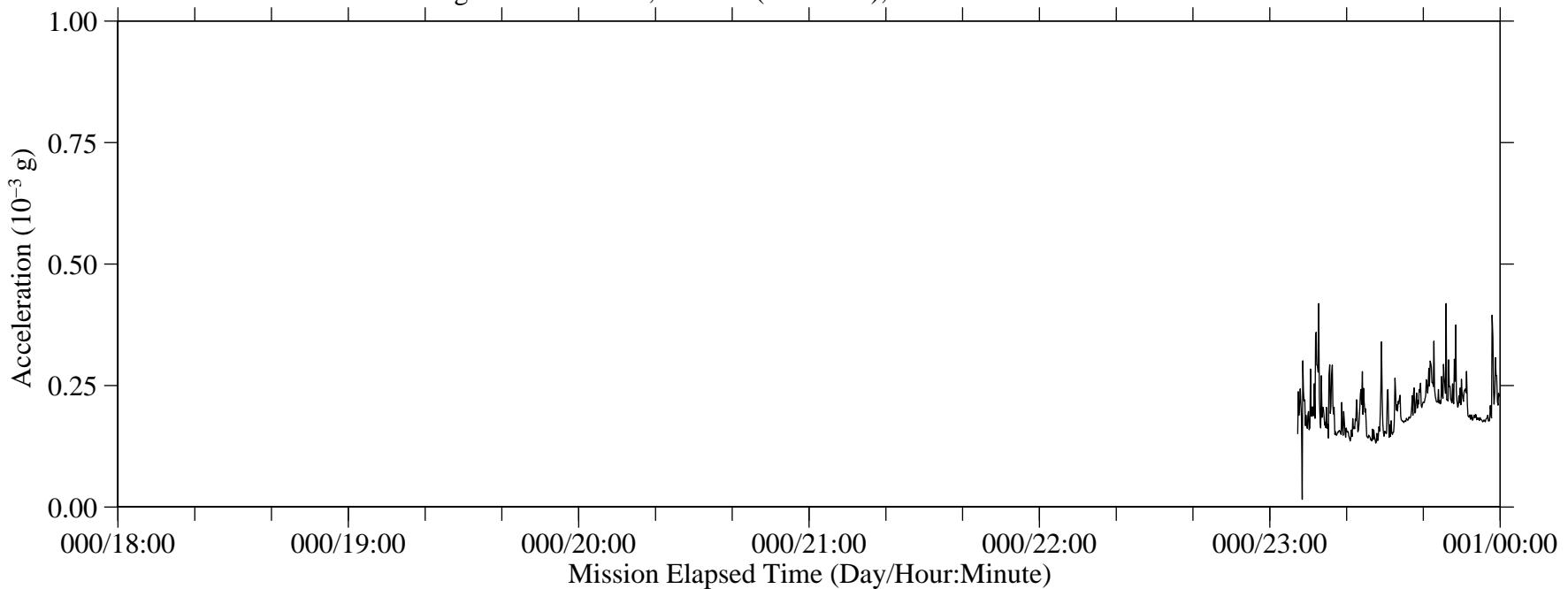


Figure 2: STS-79, Head C (fc=25 Hz)

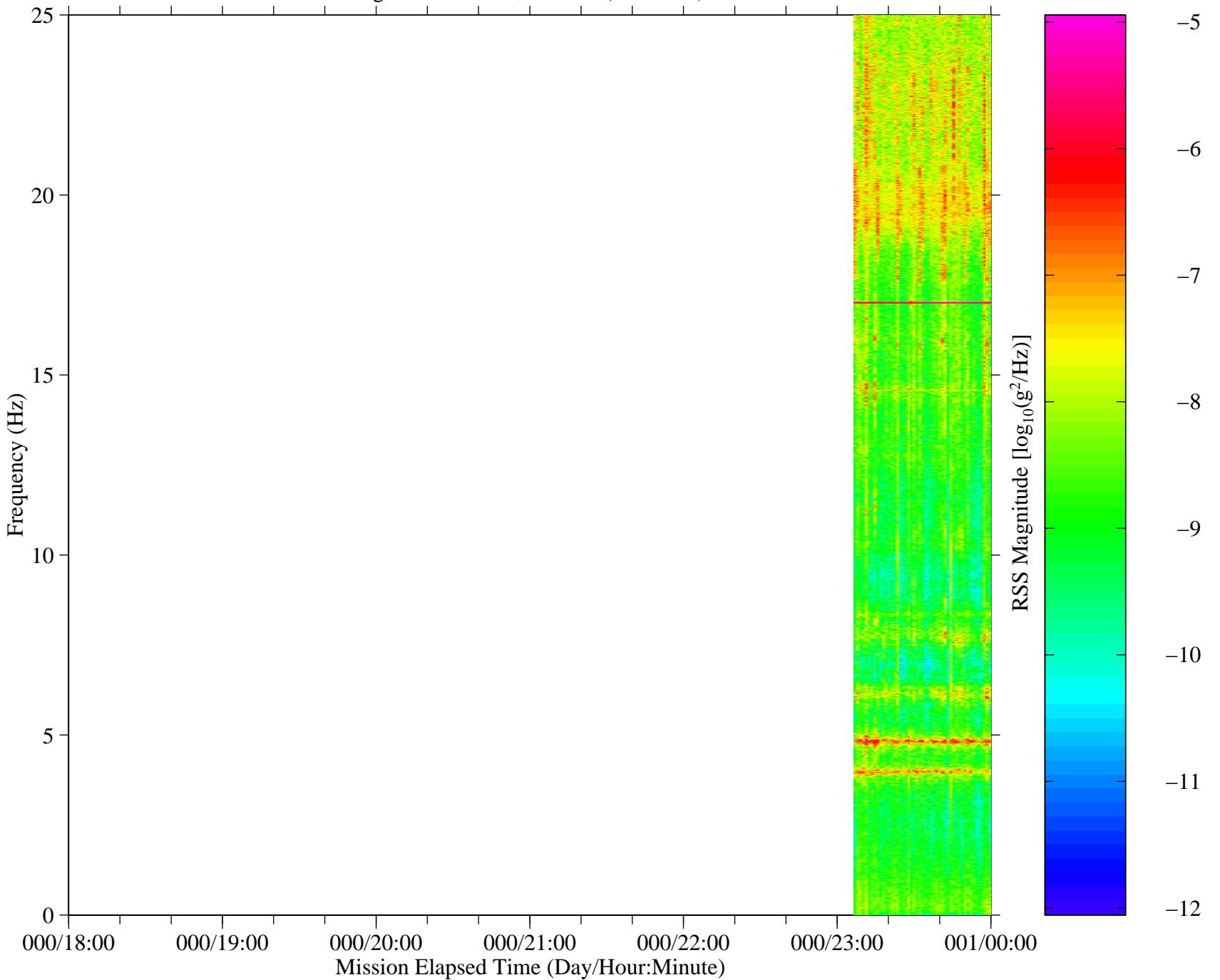
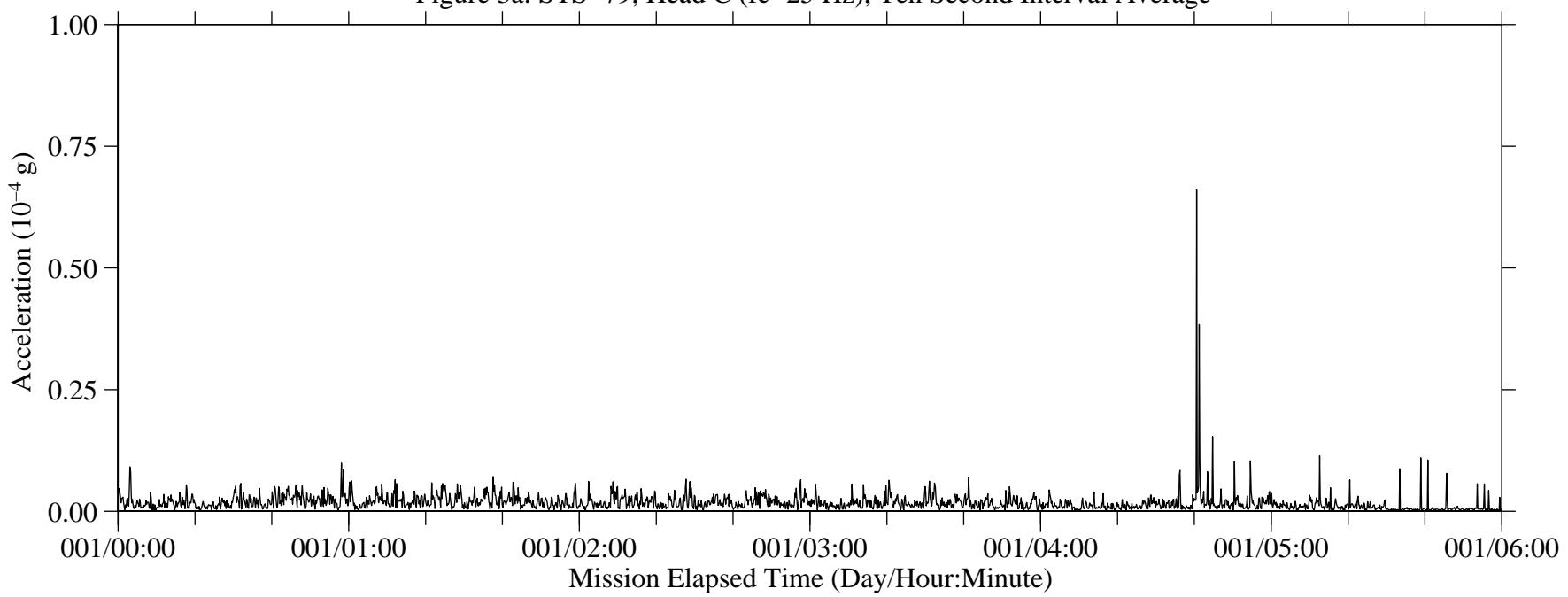


Figure 3a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-6

Figure 3b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

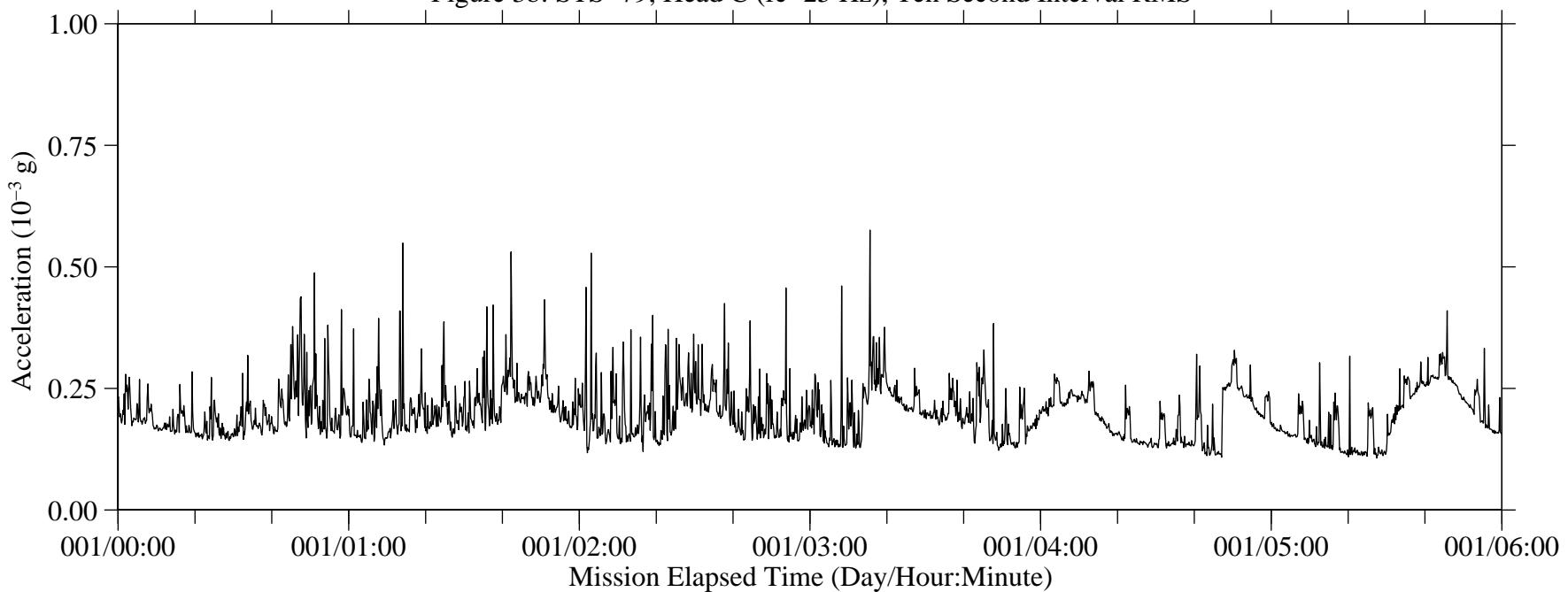


Figure 4: STS-79, Head C (fc=25 Hz)

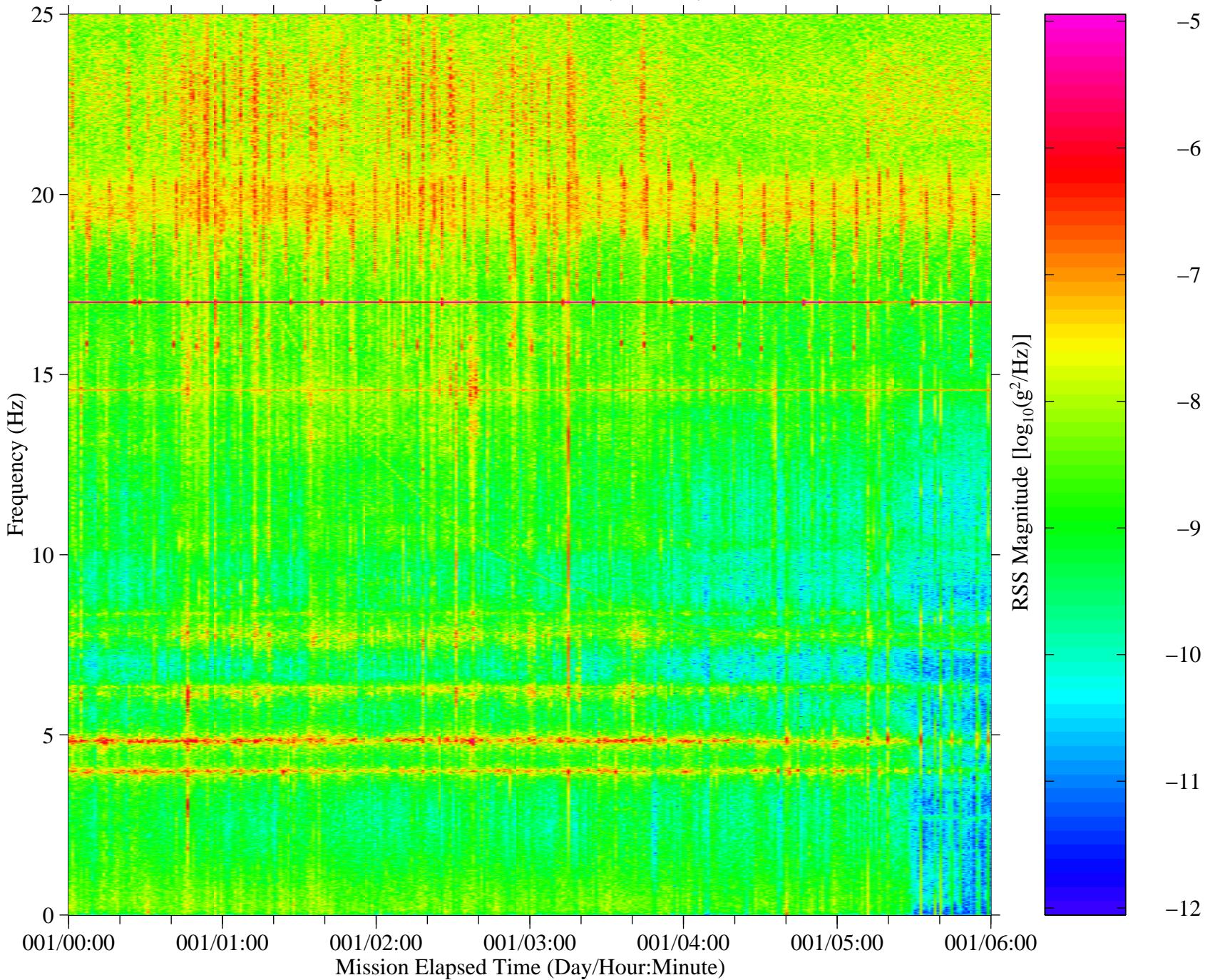
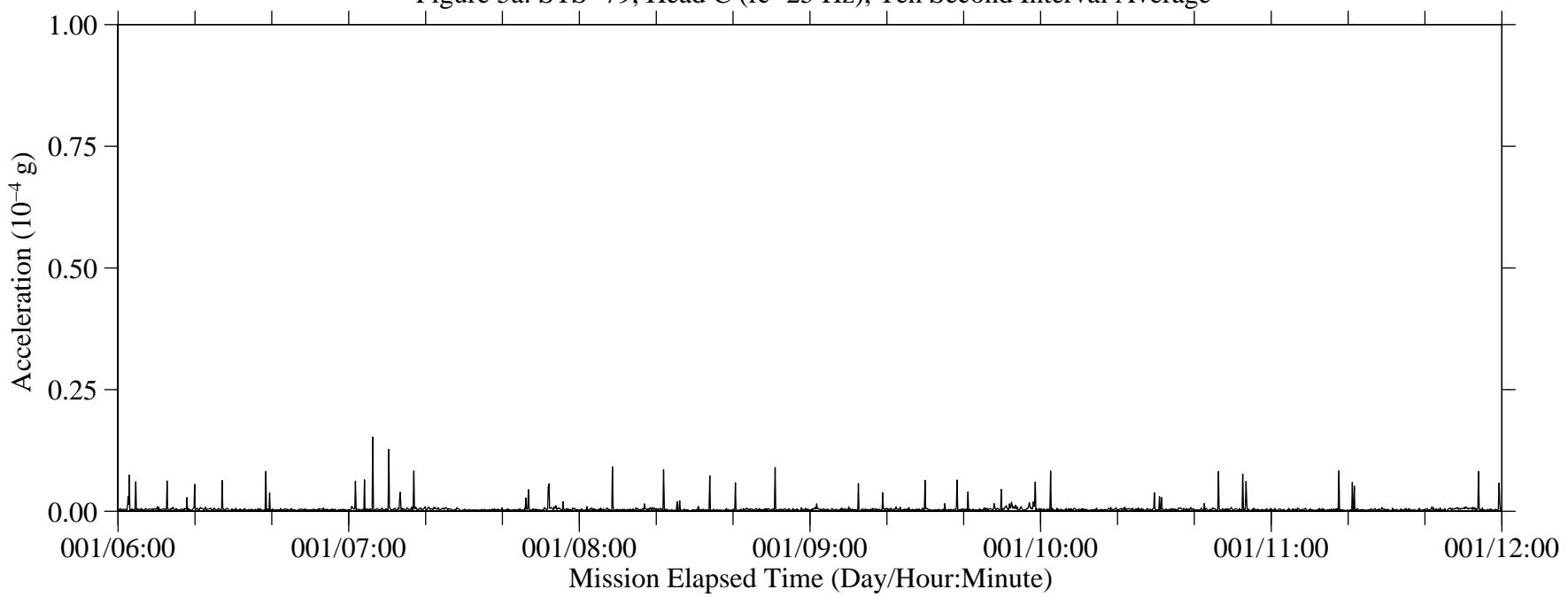


Figure 5a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-8

Figure 5b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

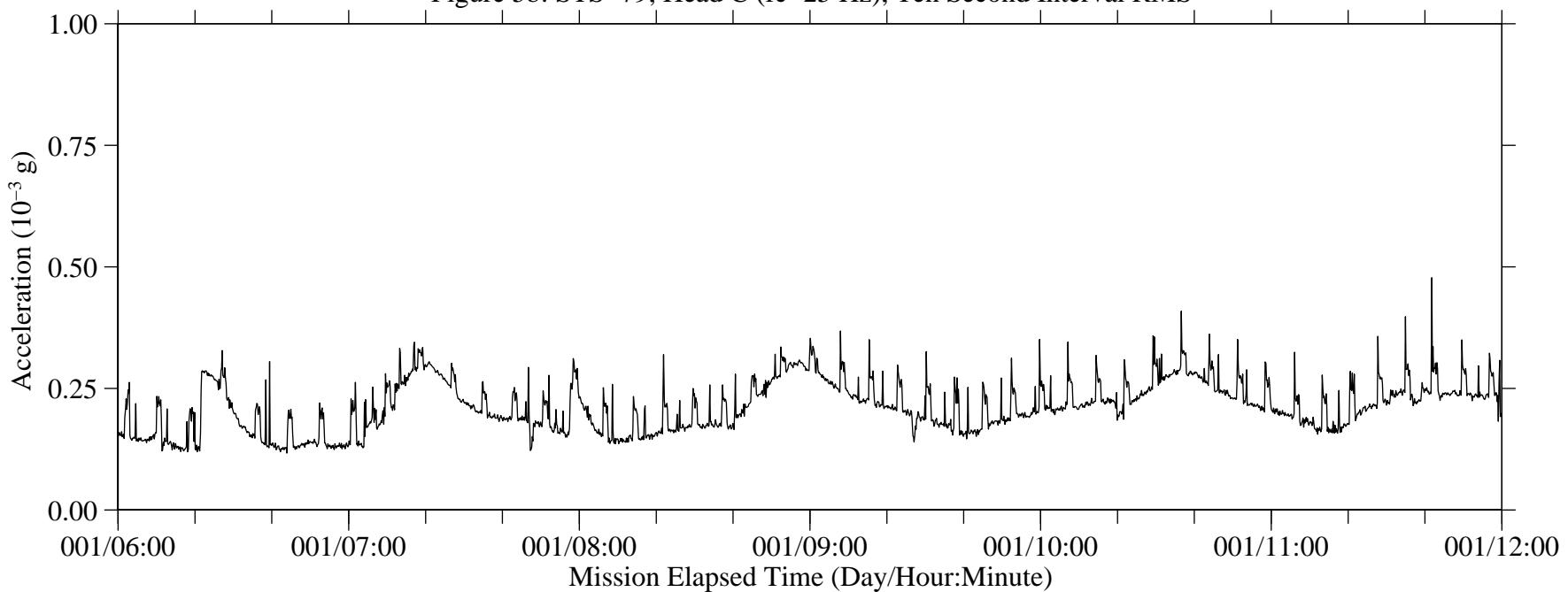


Figure 6: STS-79, Head C (fc=25 Hz)

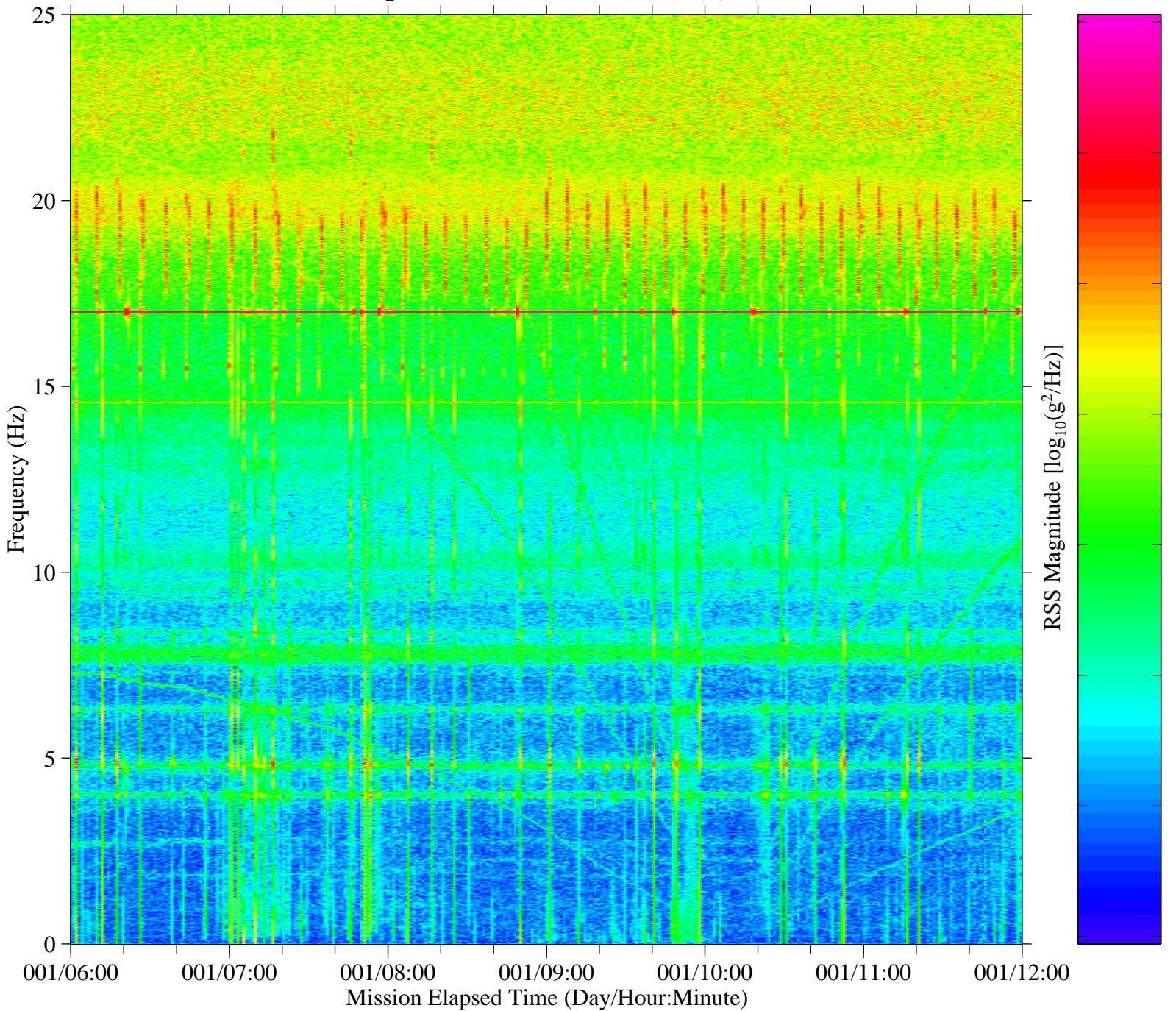


Figure 7a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

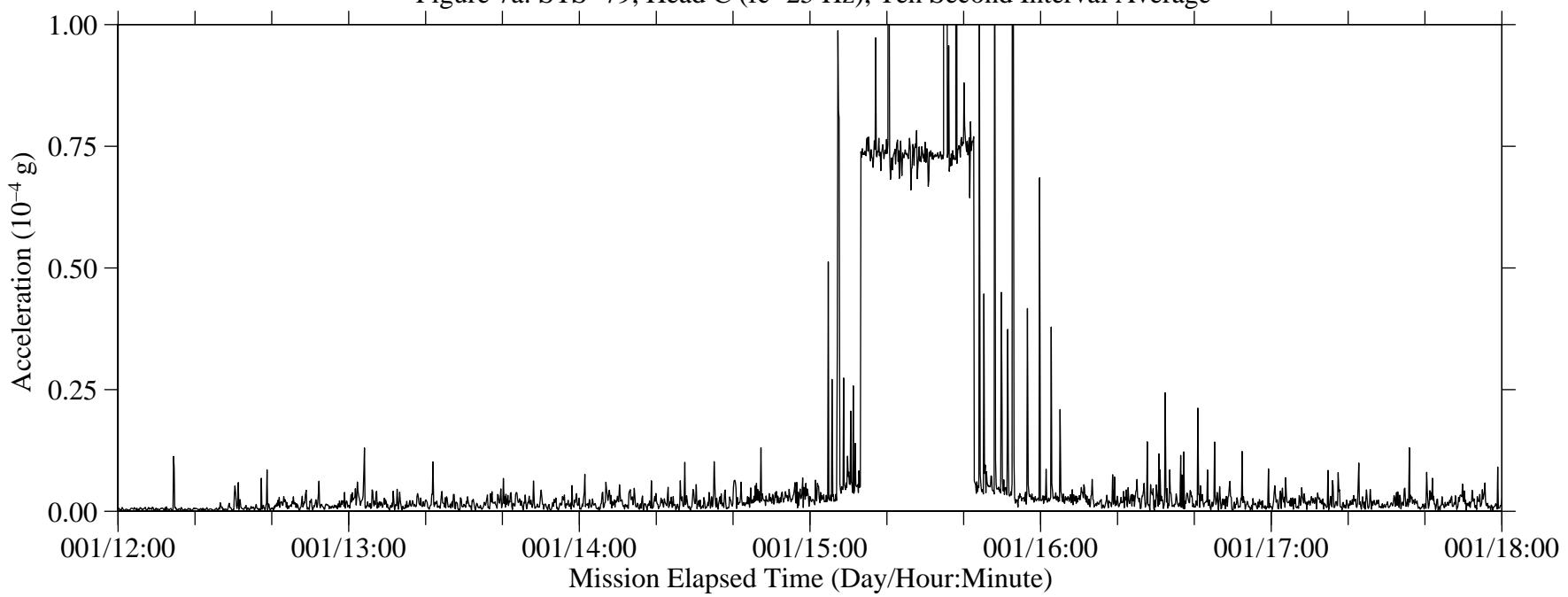


Figure 7b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

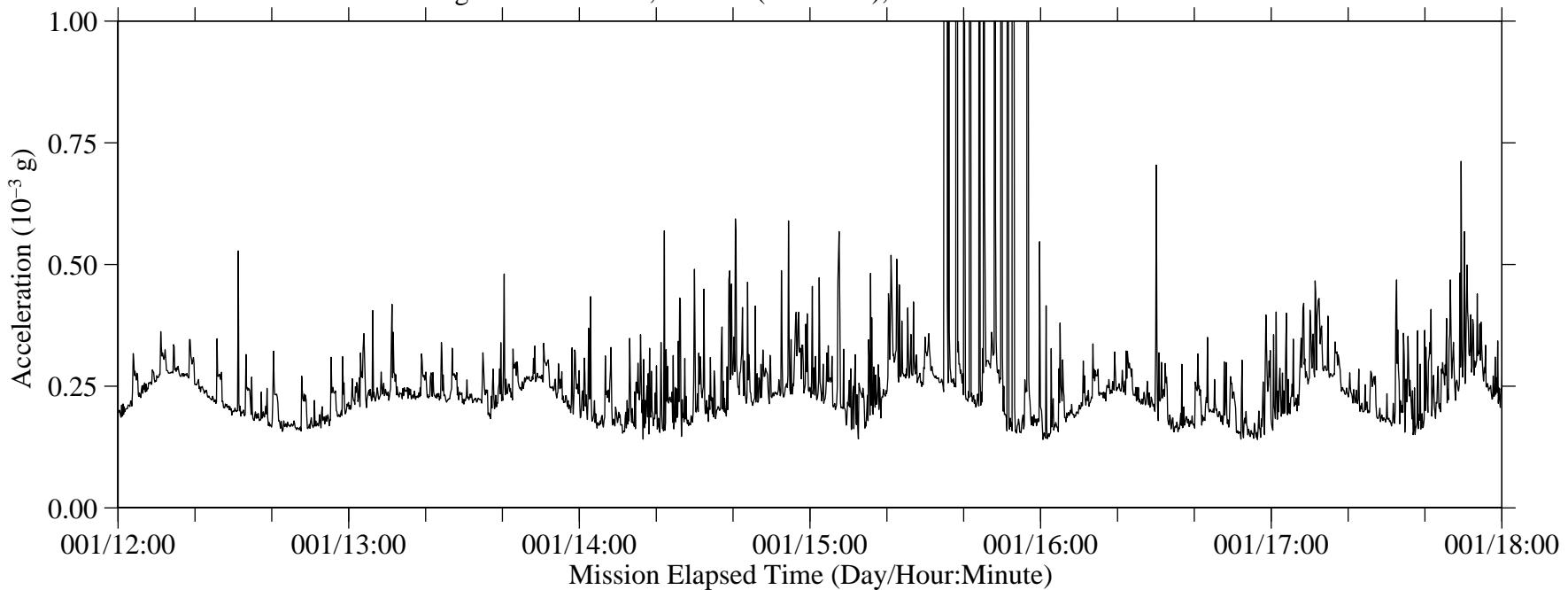


Figure 8: STS-79, Head C (fc=25 Hz)

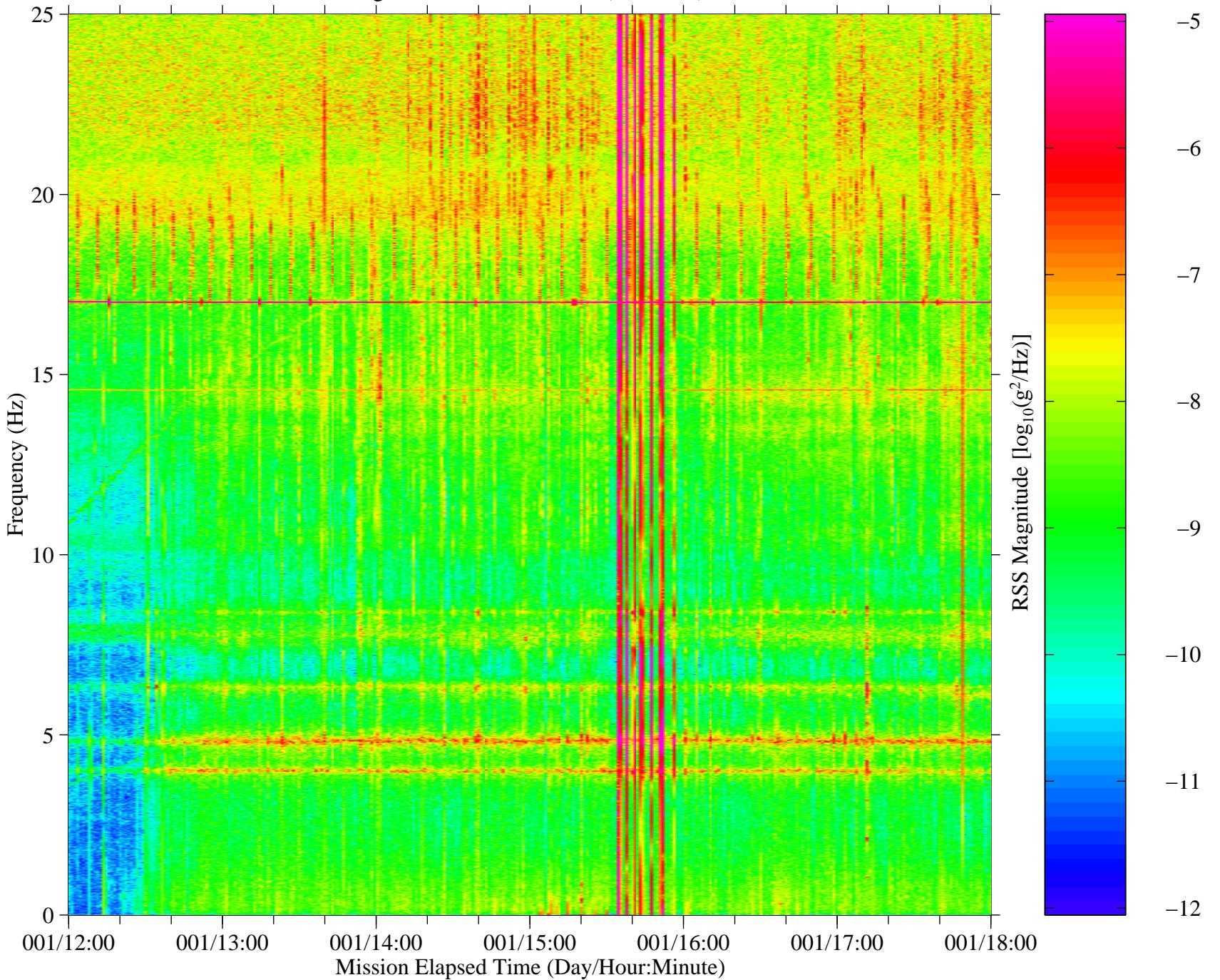


Figure 9a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

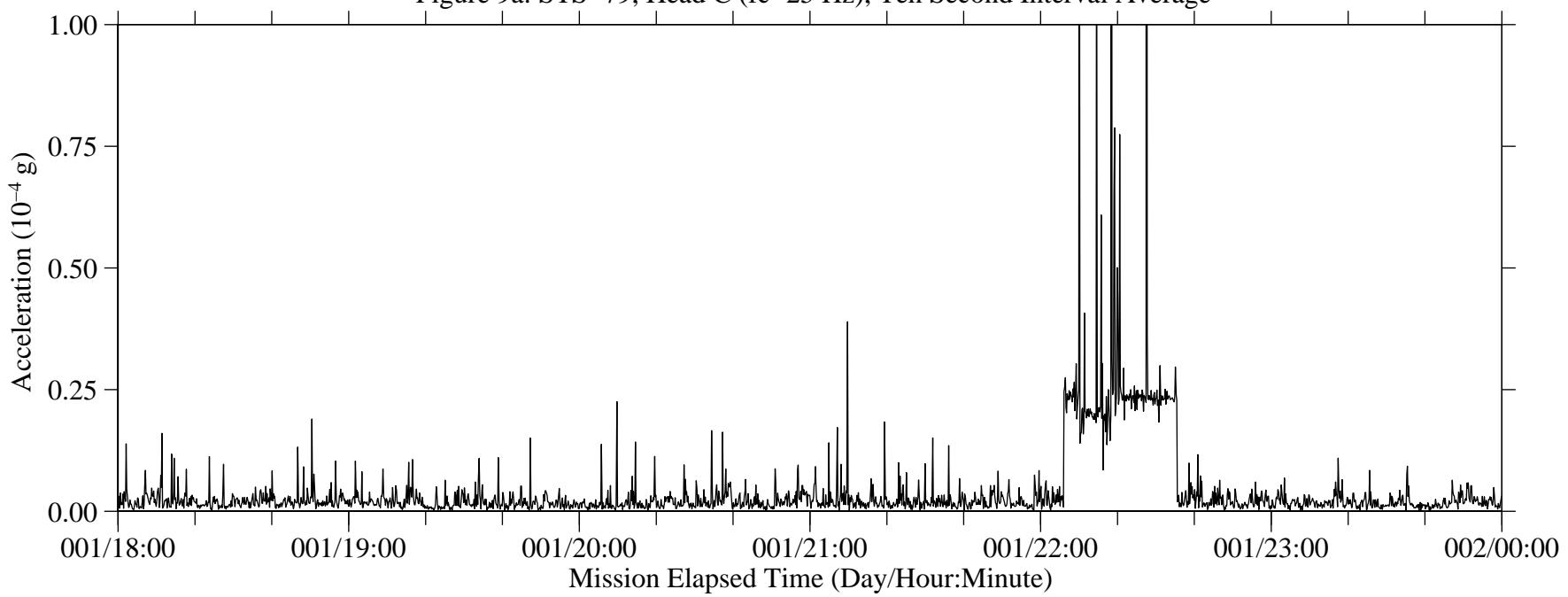


Figure 9b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

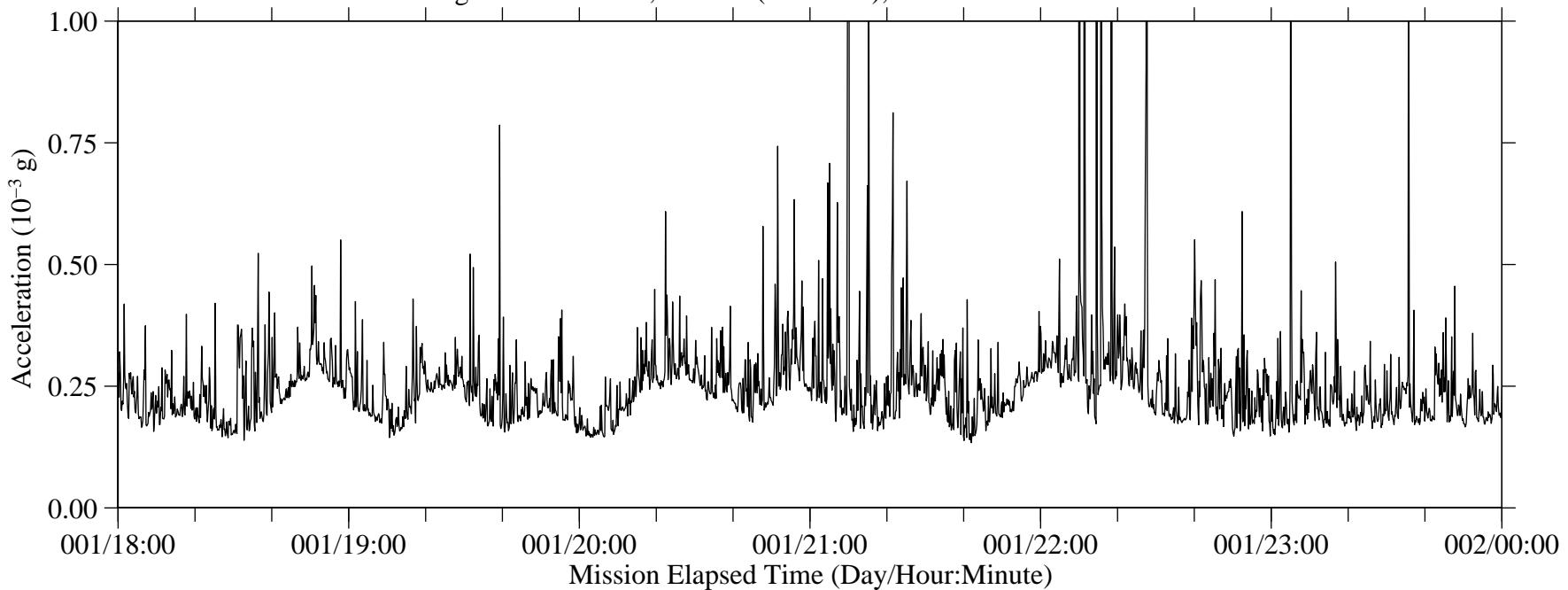


Figure 10: STS-79, Head C (fc=25 Hz)

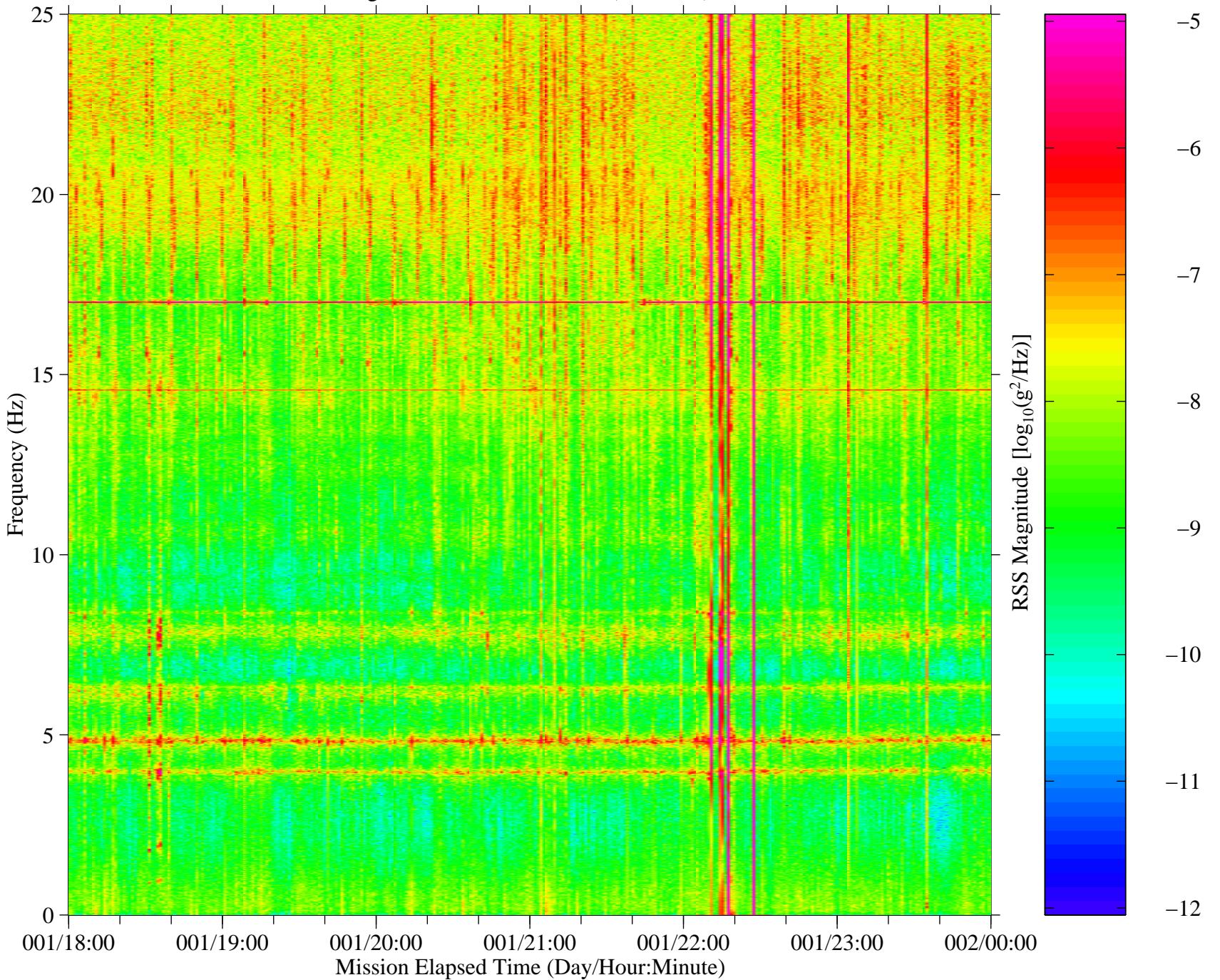
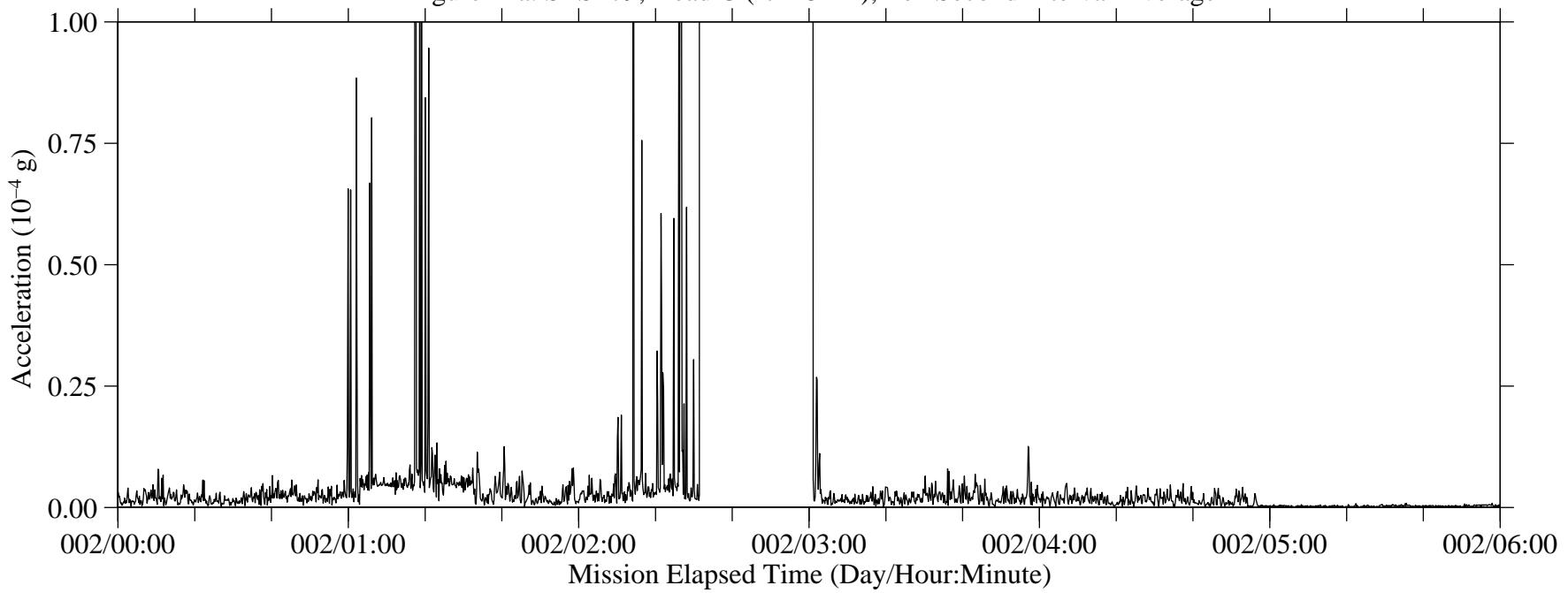


Figure 11a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-14

Figure 11b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

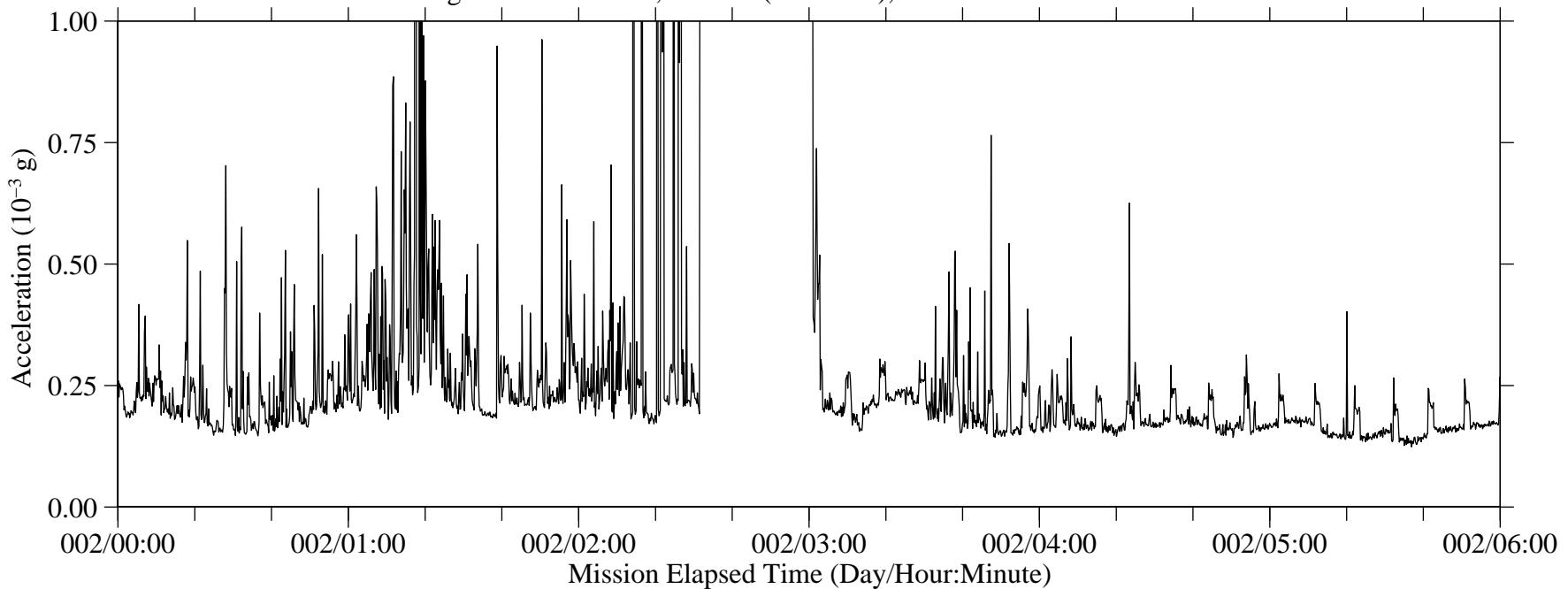


Figure 12: STS-79, Head C (fc=25 Hz)

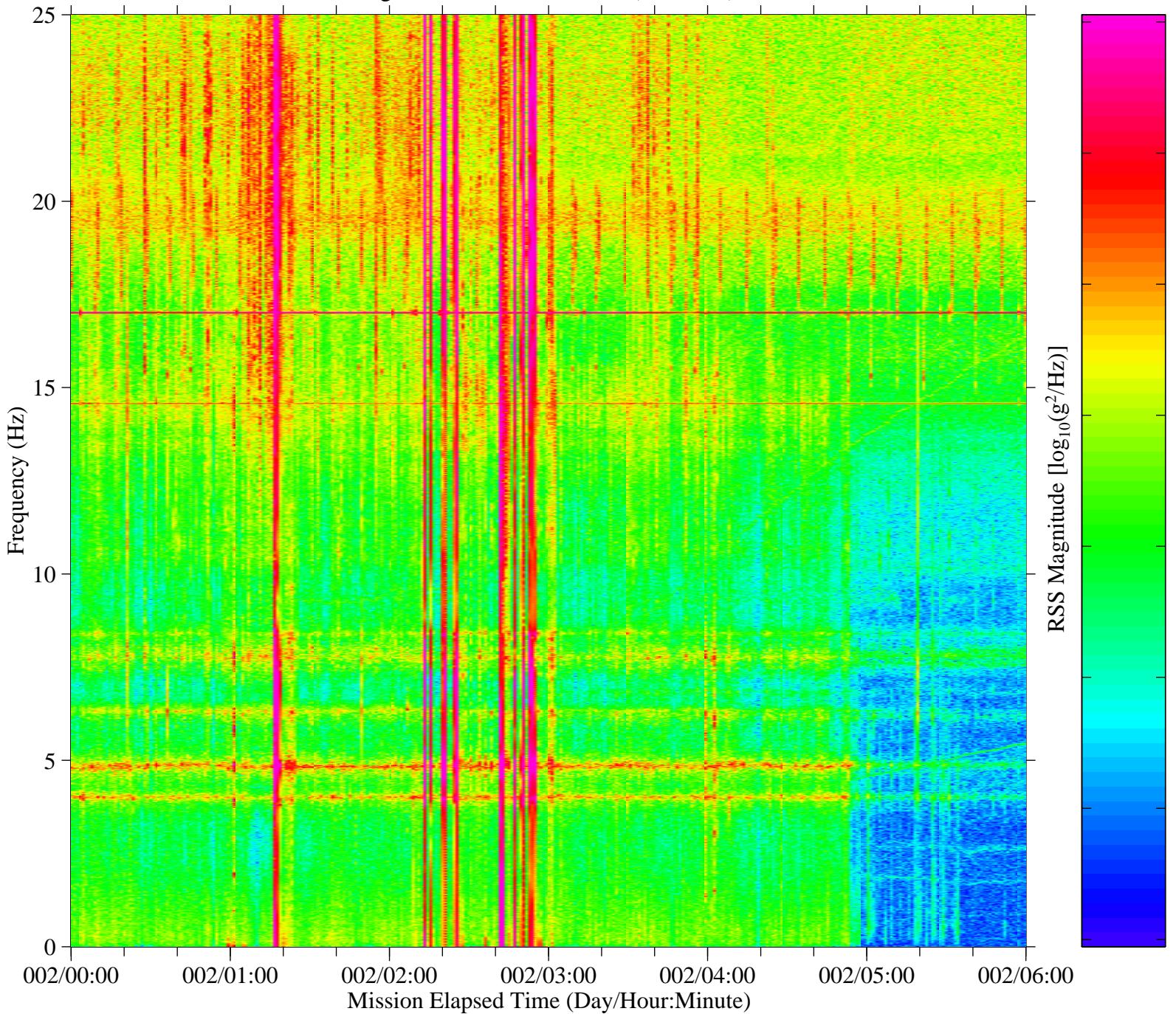


Figure 13a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

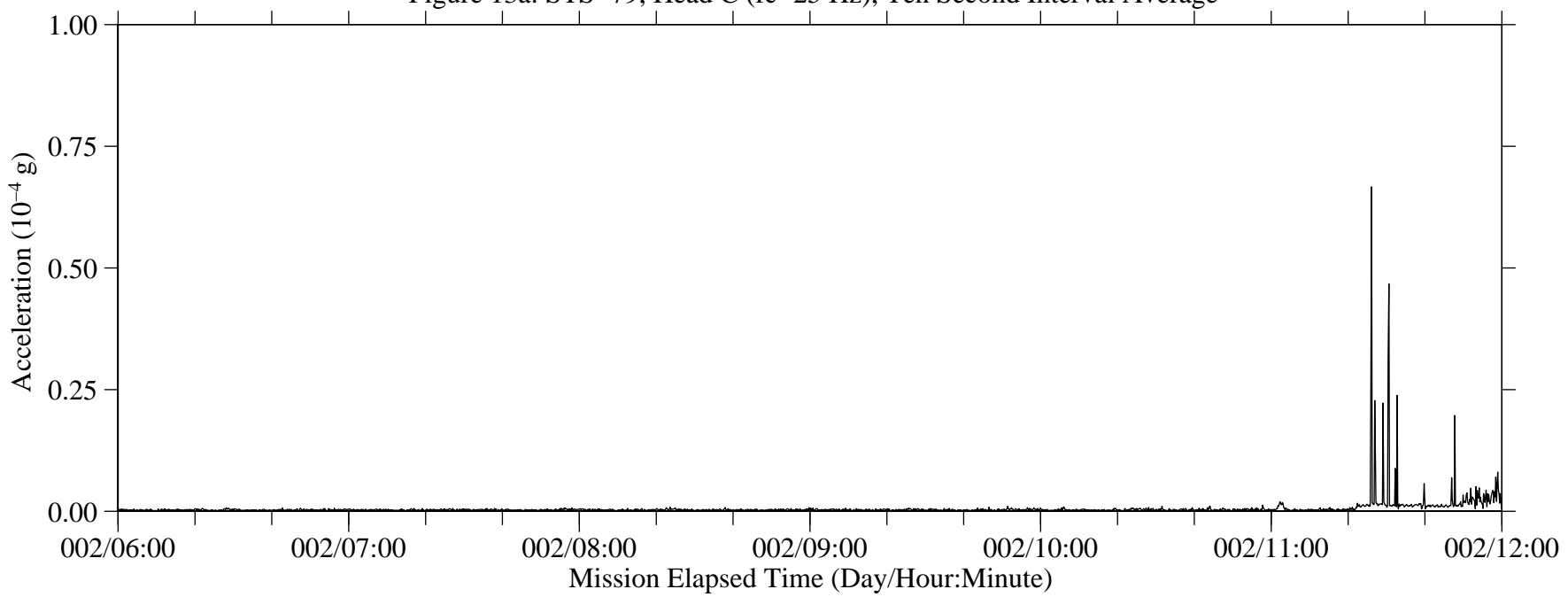


Figure 13b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

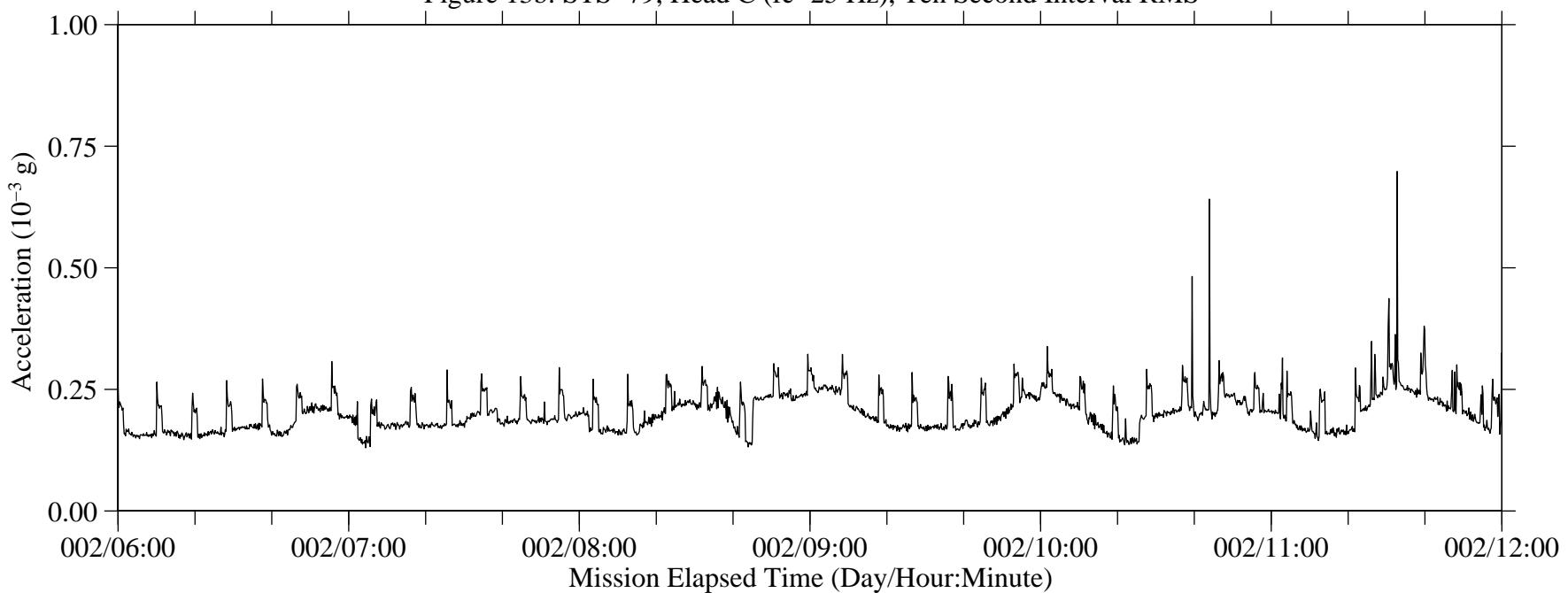


Figure 14: STS-79, Head C (fc=25 Hz)

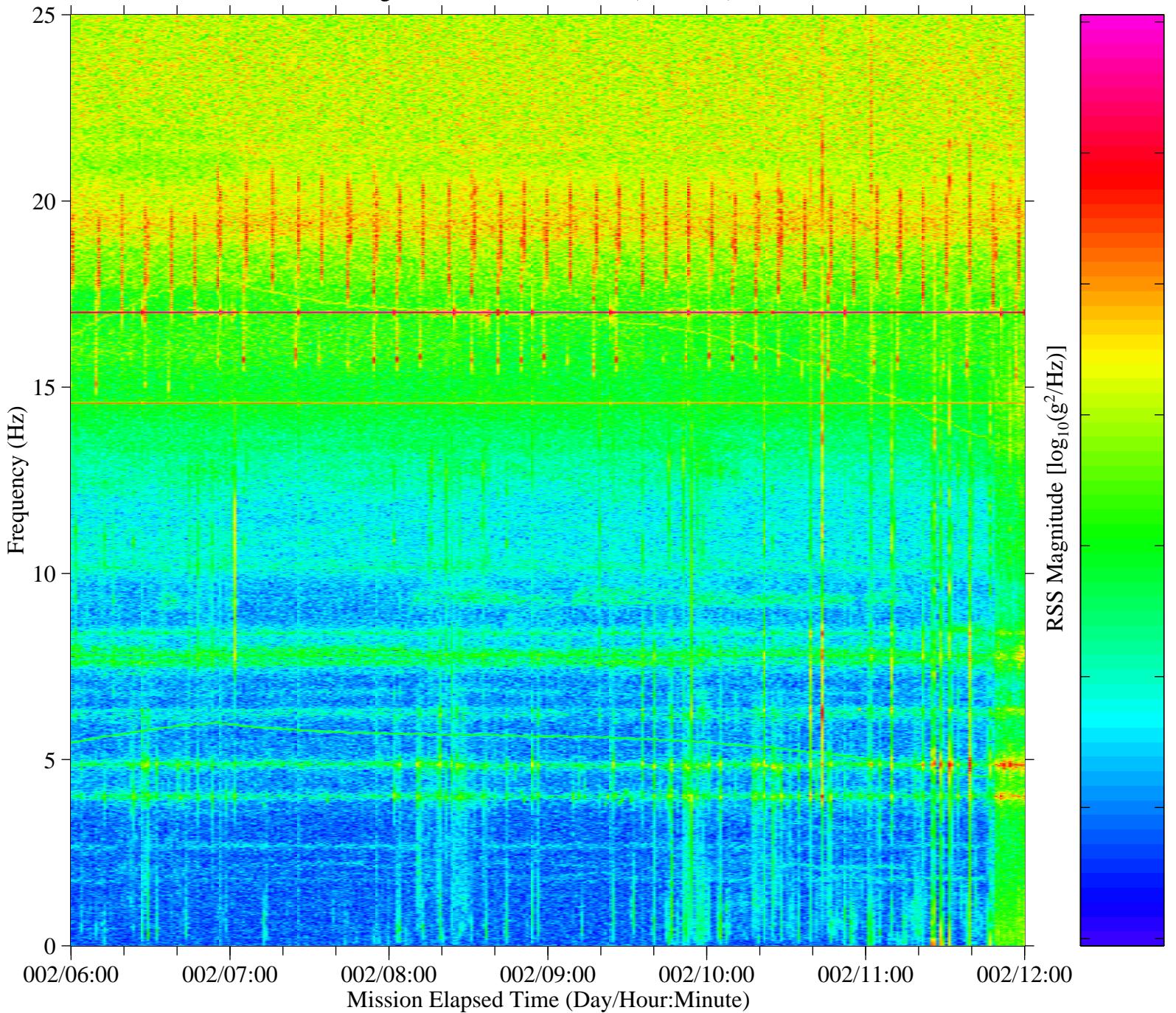


Figure 15a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

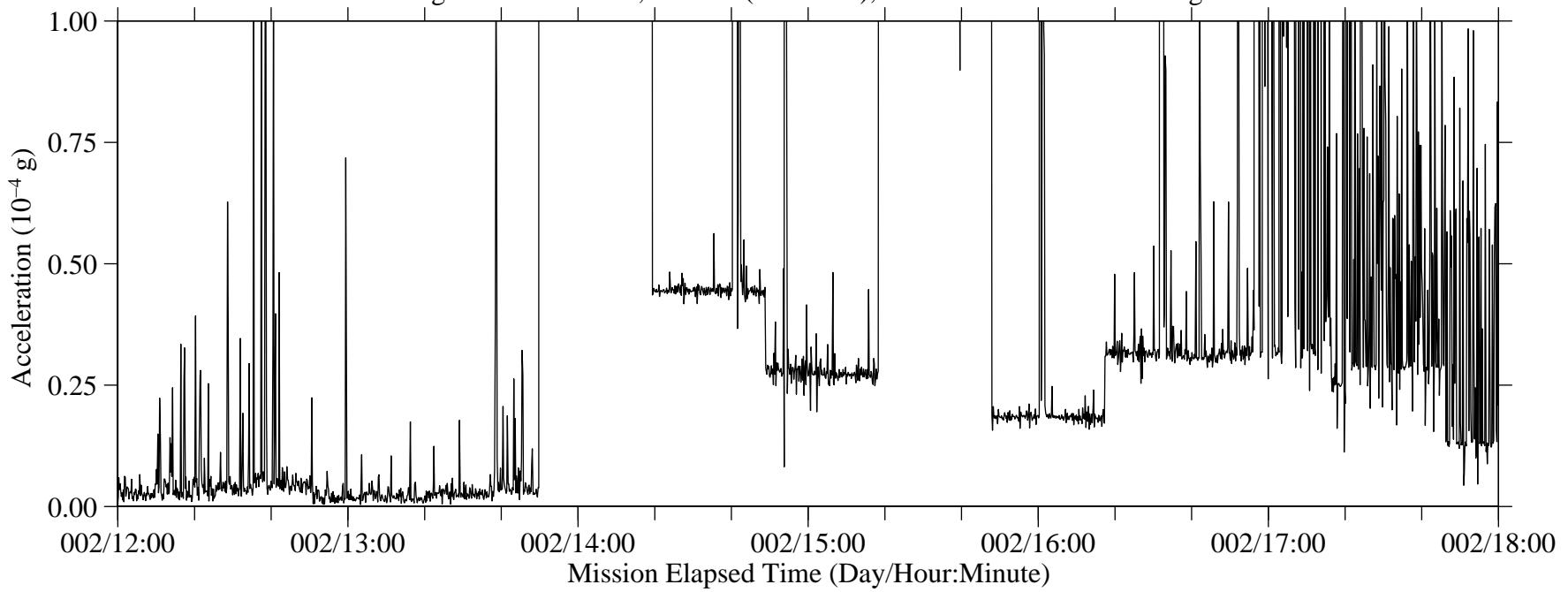


Figure 15b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

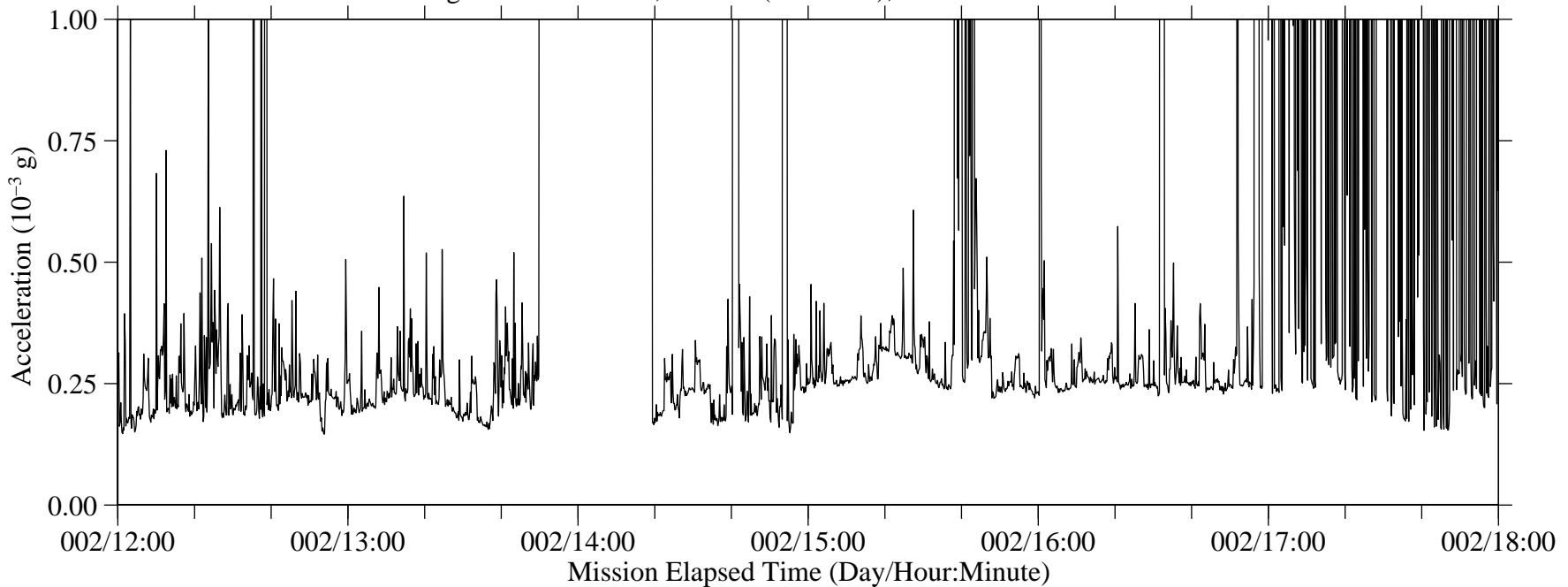


Figure 16: STS-79, Head C (fc=25 Hz)

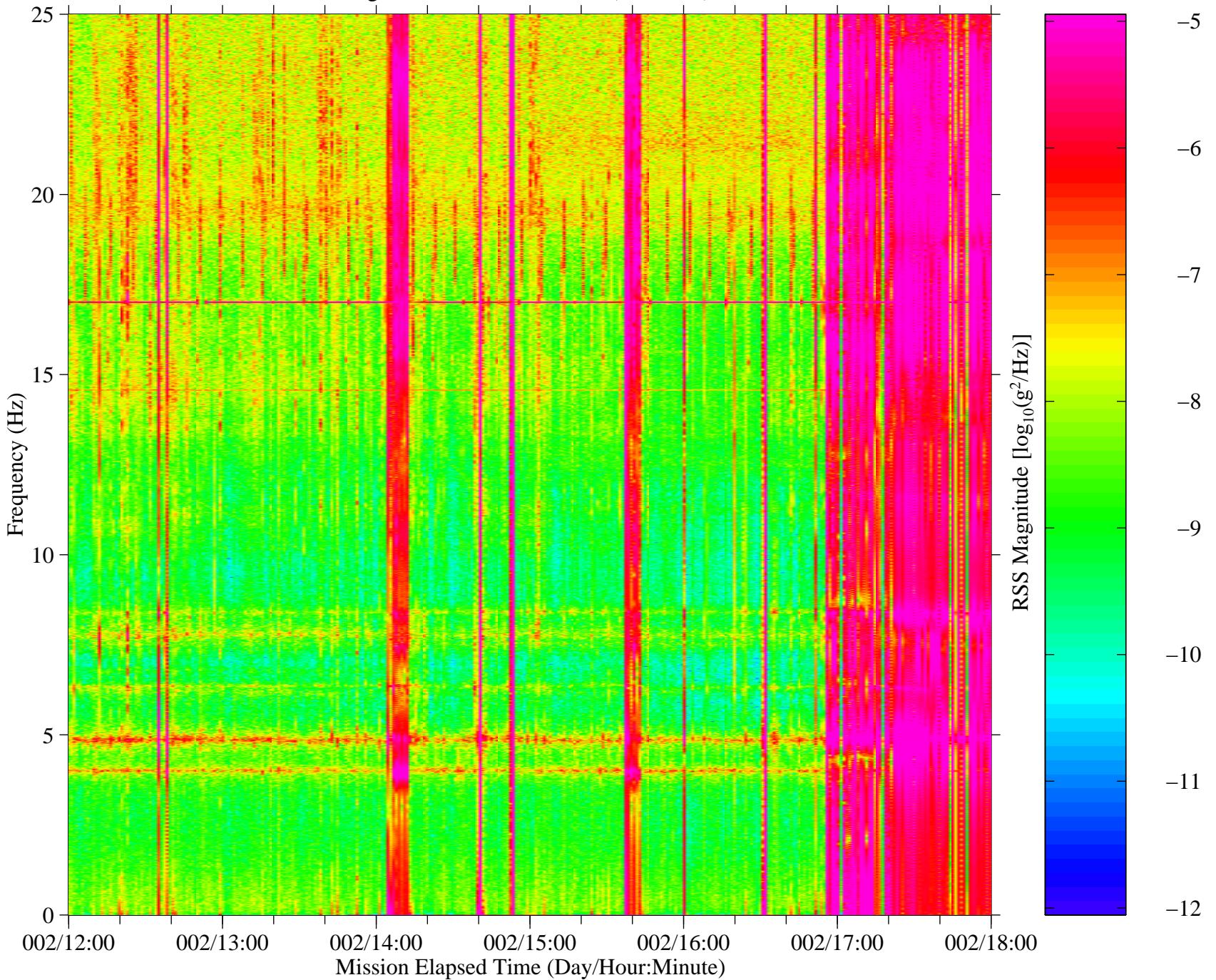


Figure 17a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

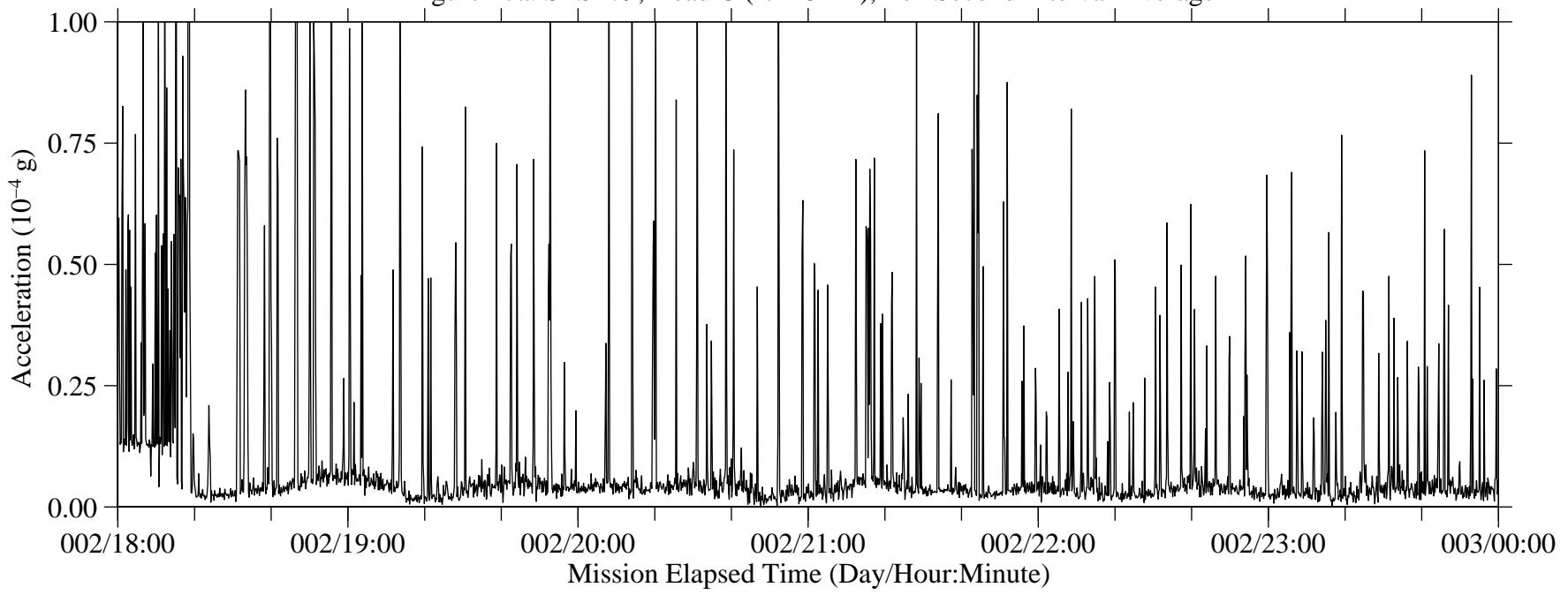


Figure 17b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

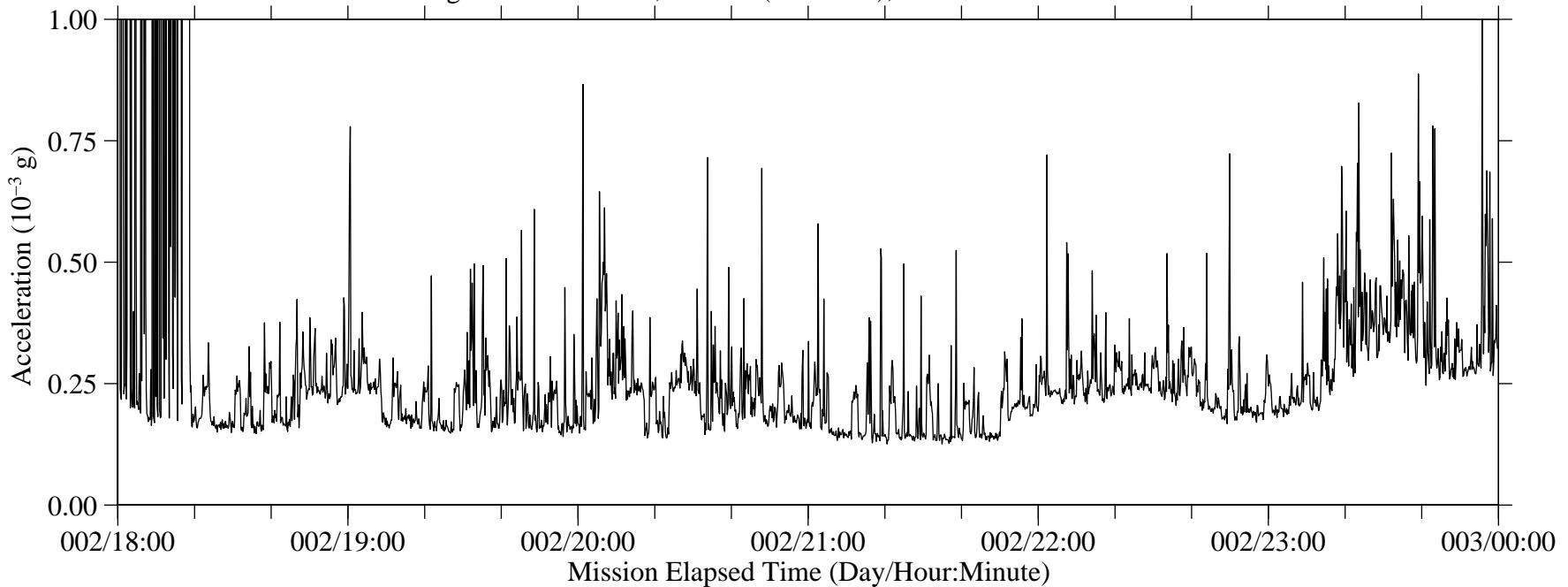


Figure 18: STS-79, Head C (fc=25 Hz)

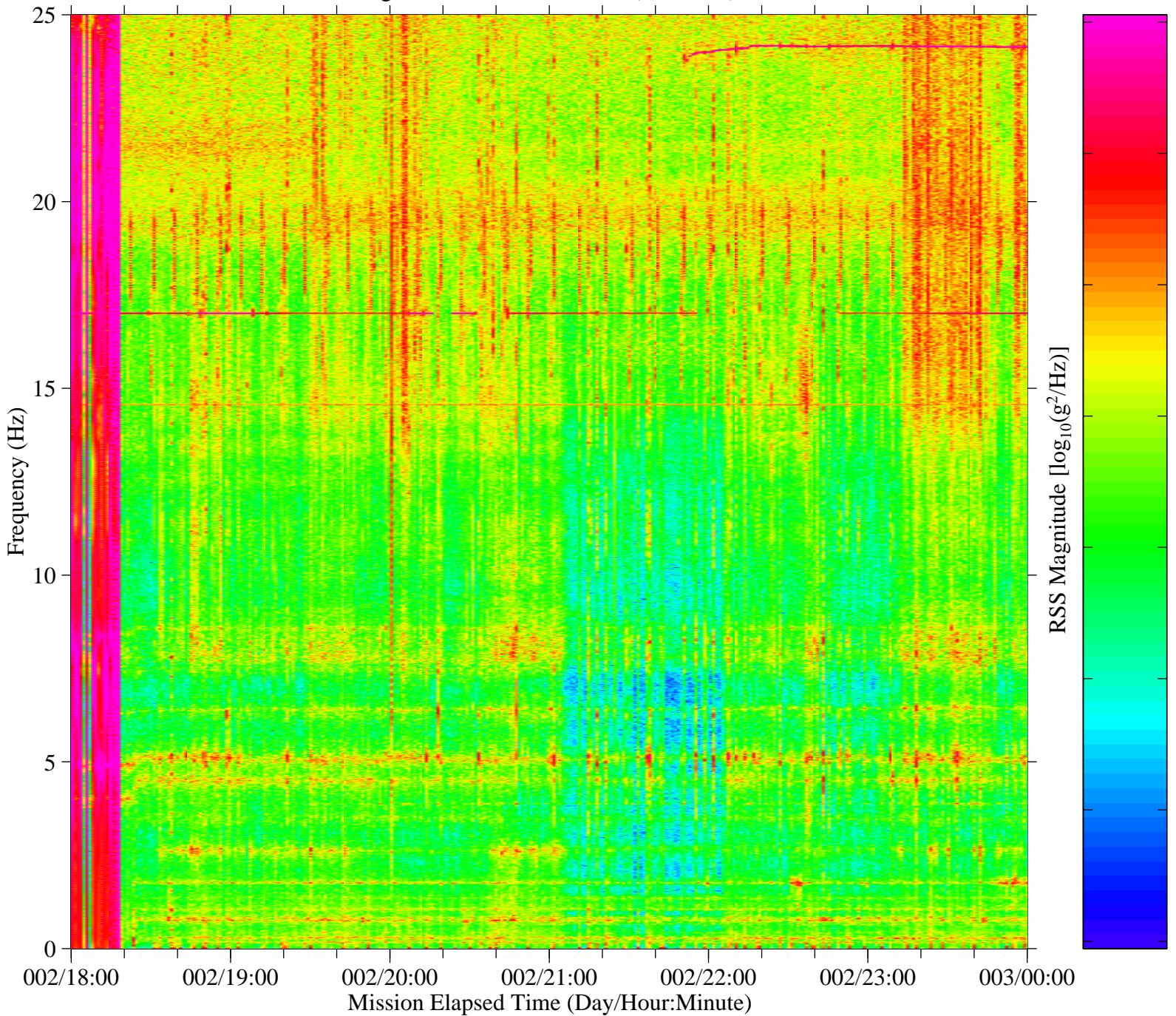
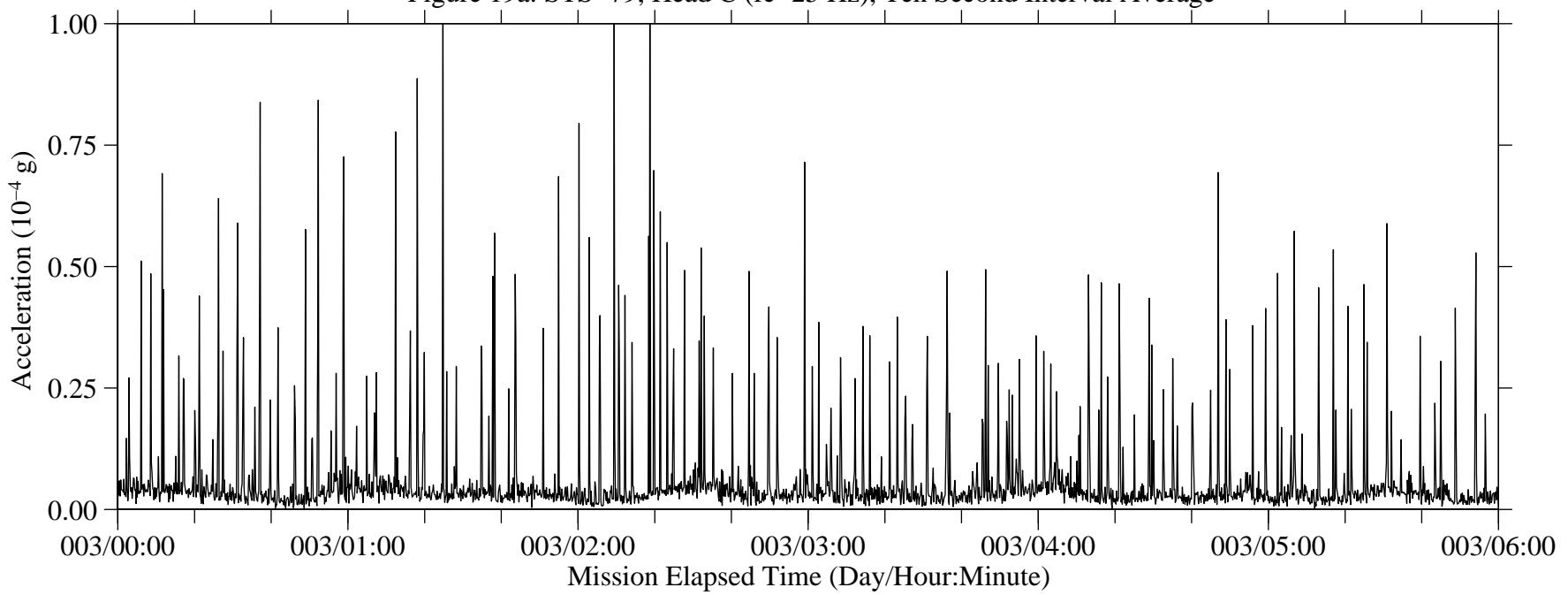
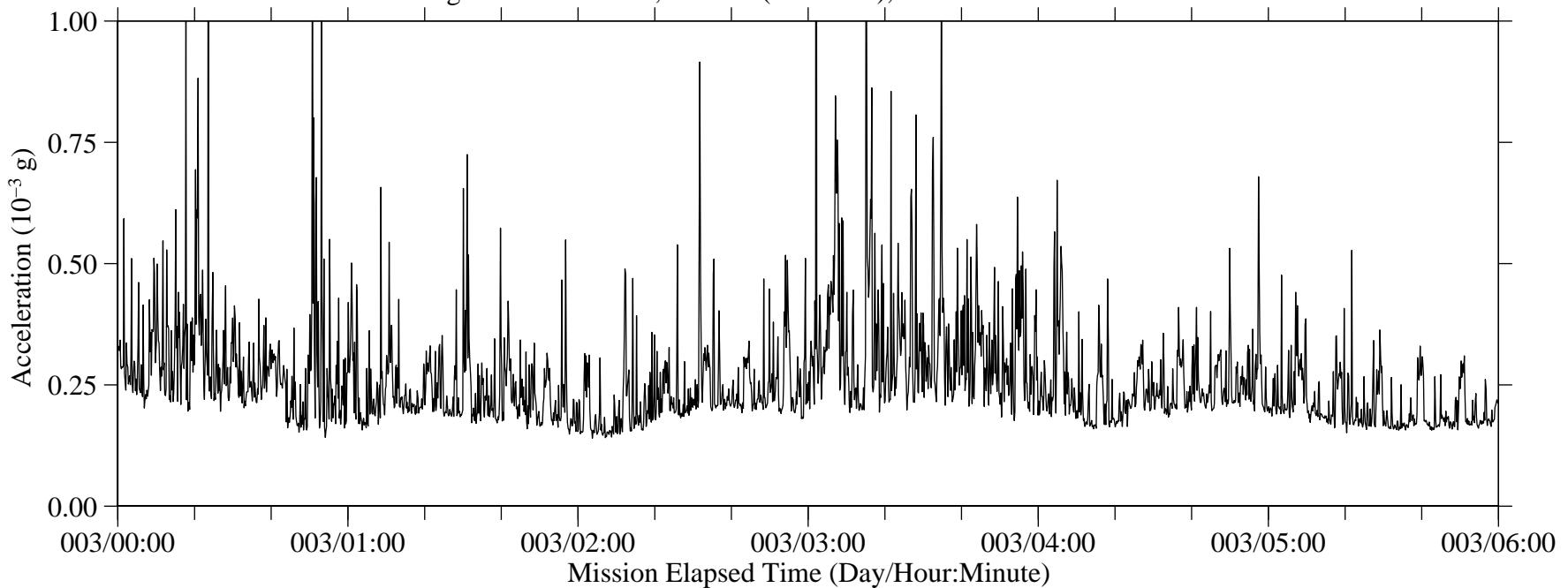


Figure 19a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-22

Figure 19b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS



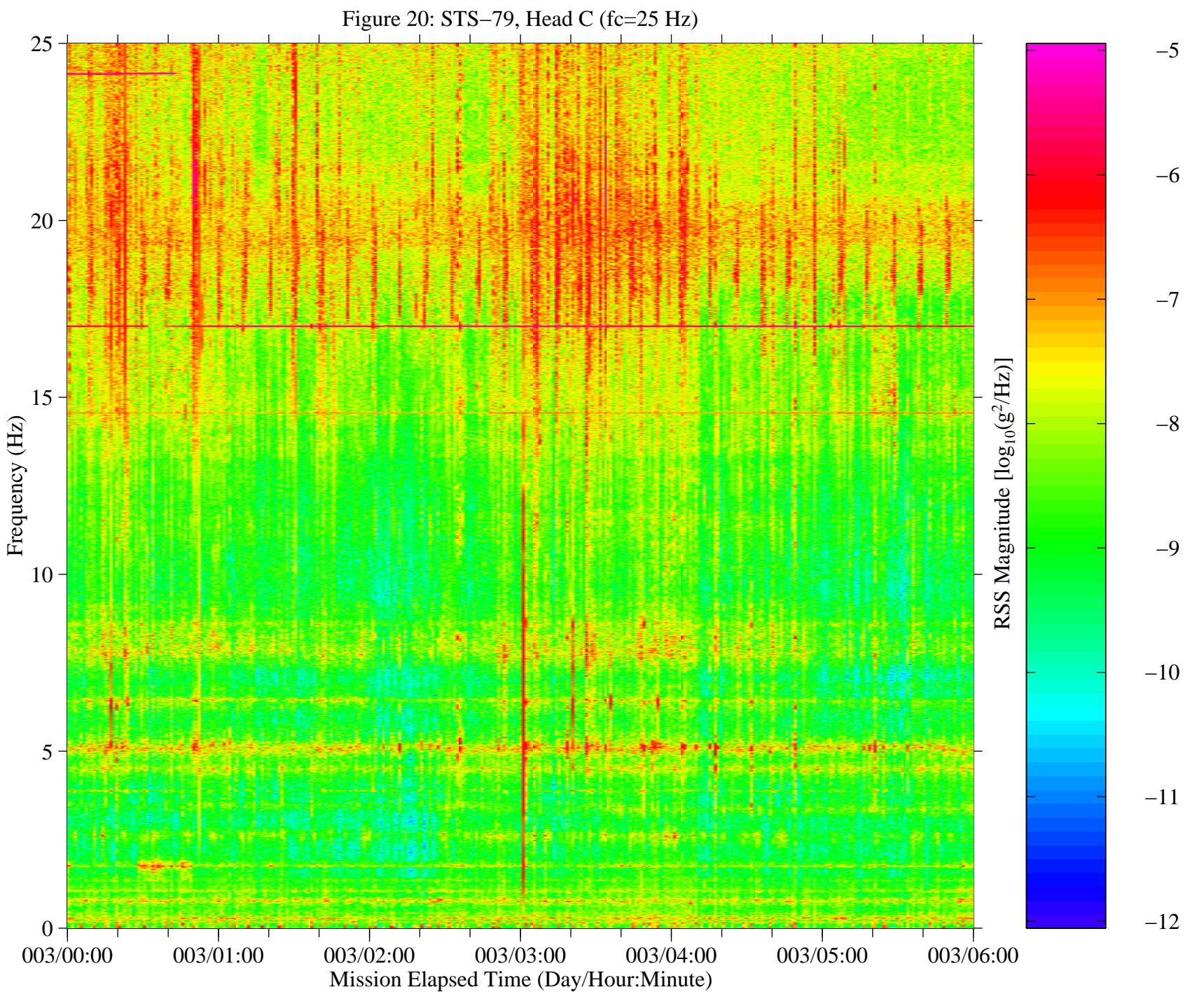


Figure 21a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

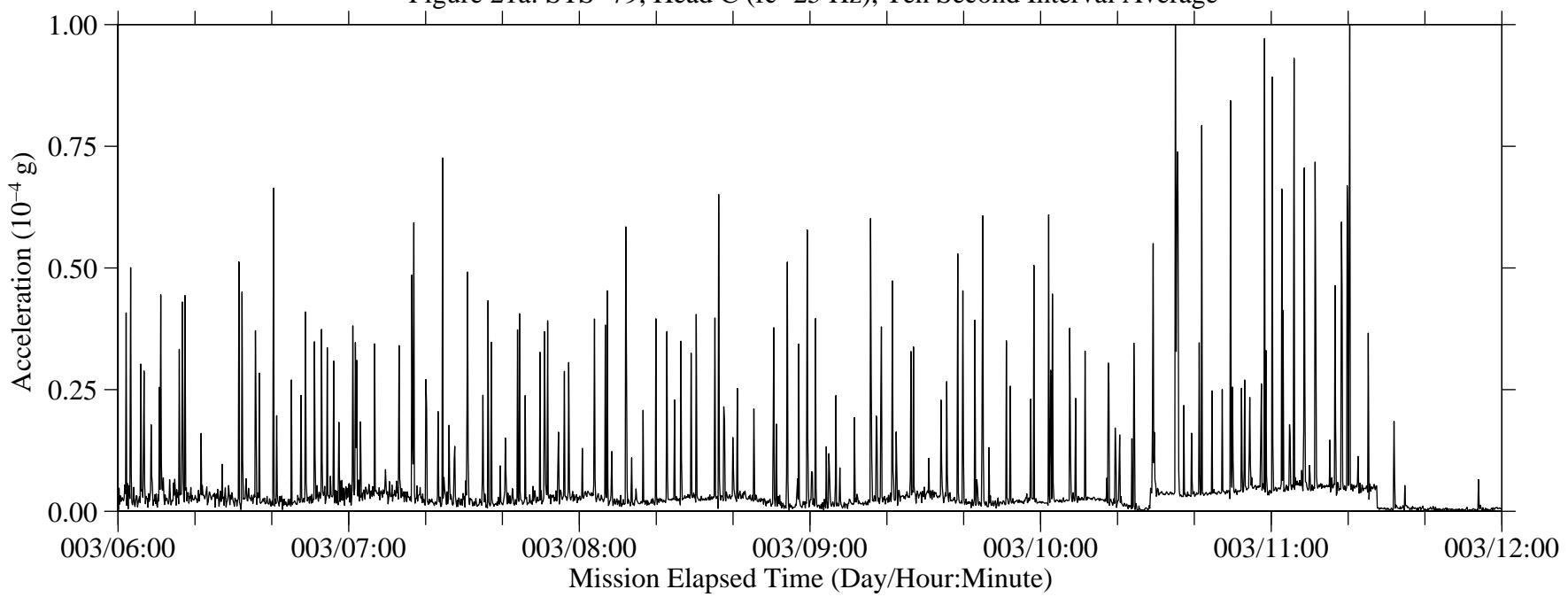


Figure 21b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

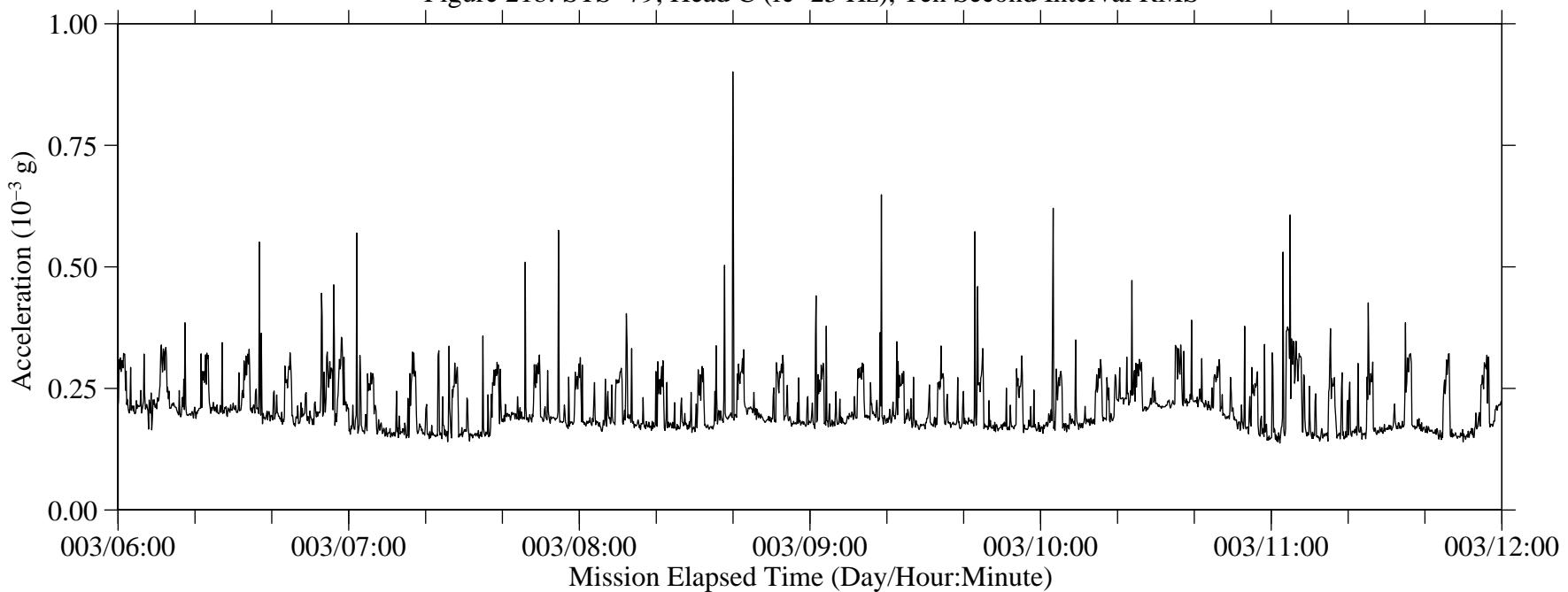


Figure 22: STS-79, Head C (fc=25 Hz)

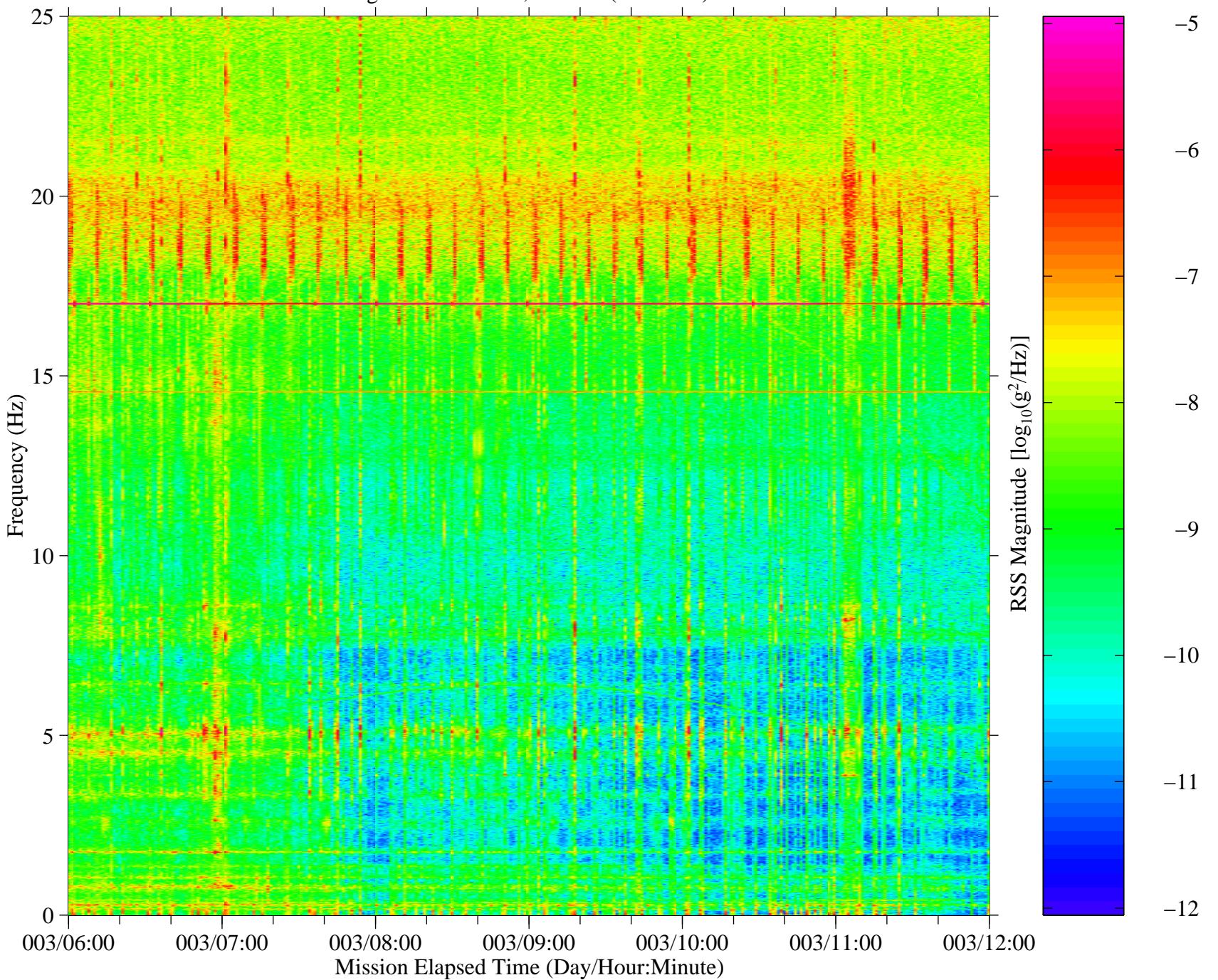


Figure 23a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

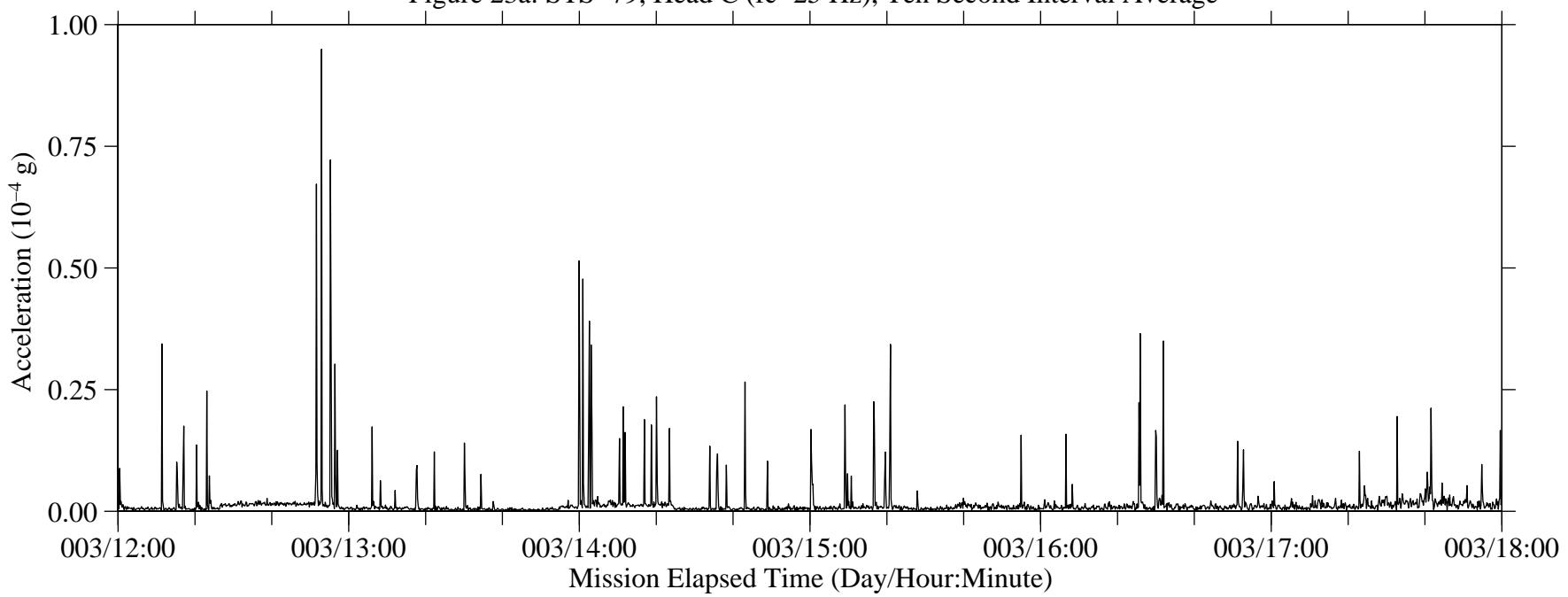


Figure 23b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

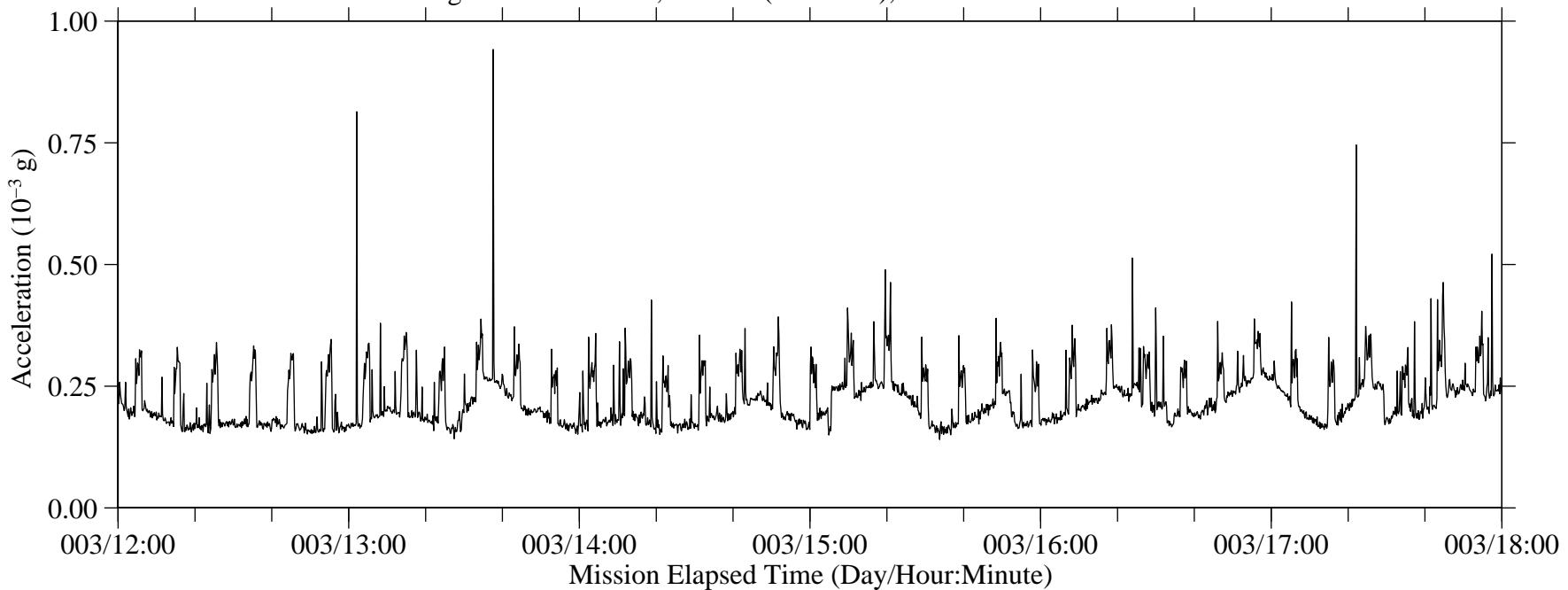


Figure 24: STS-79, Head C (fc=25 Hz)

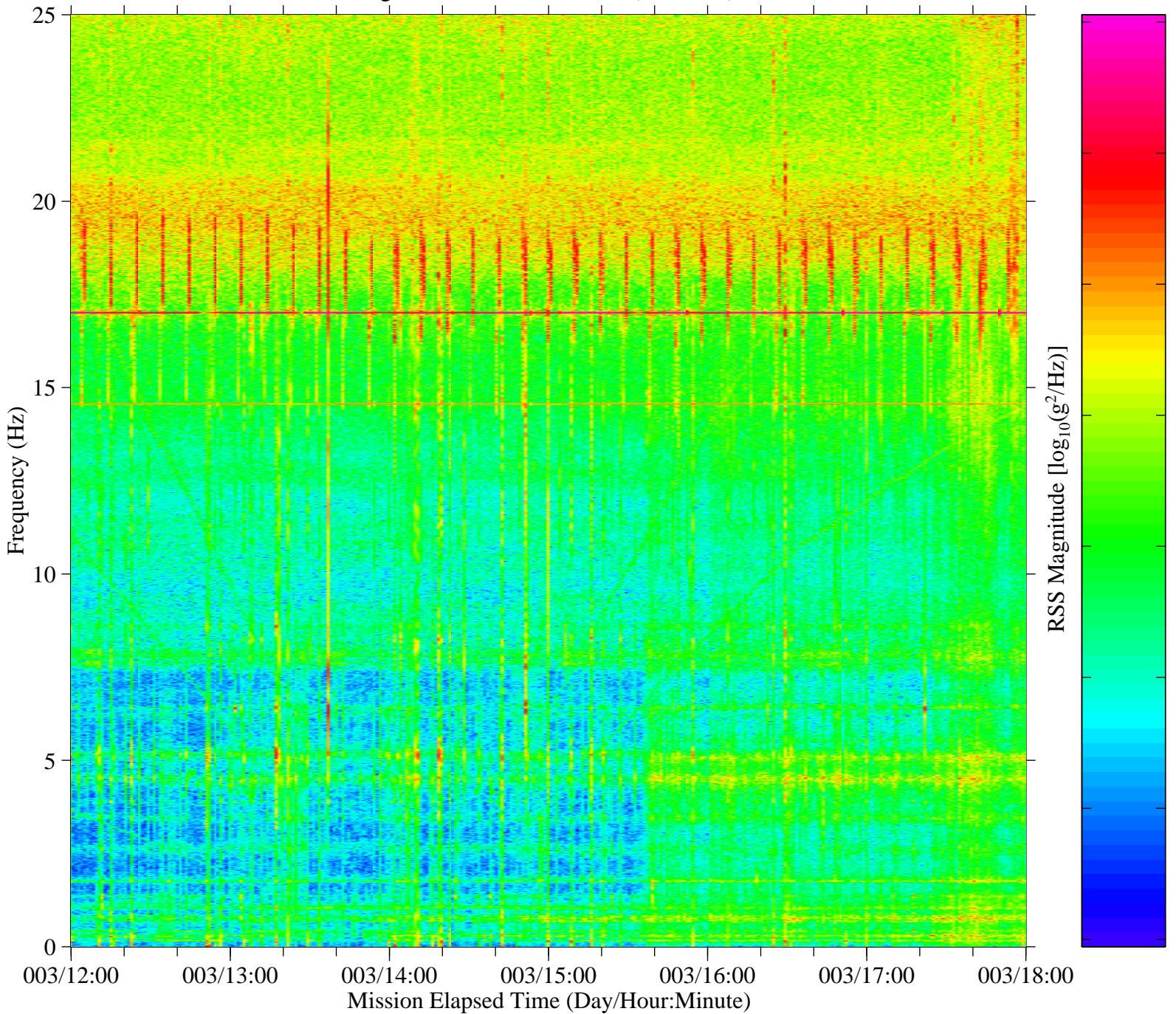


Figure 25a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

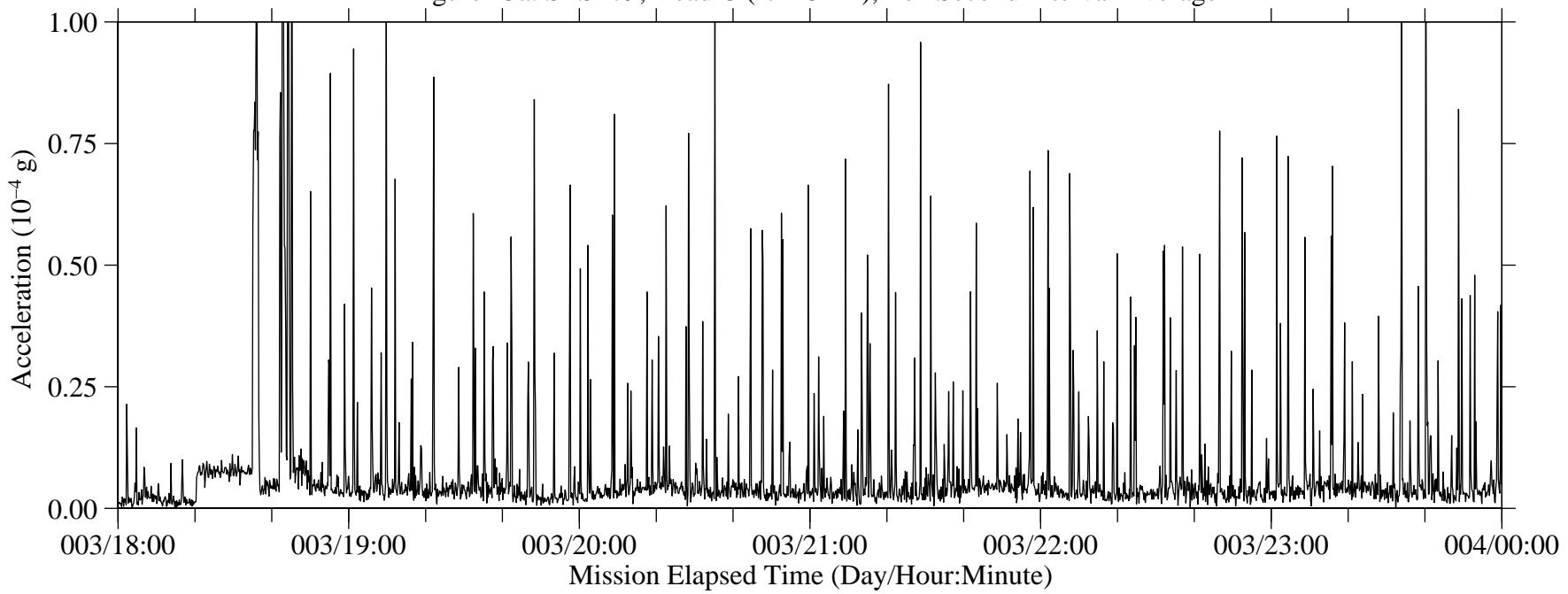


Figure 25b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

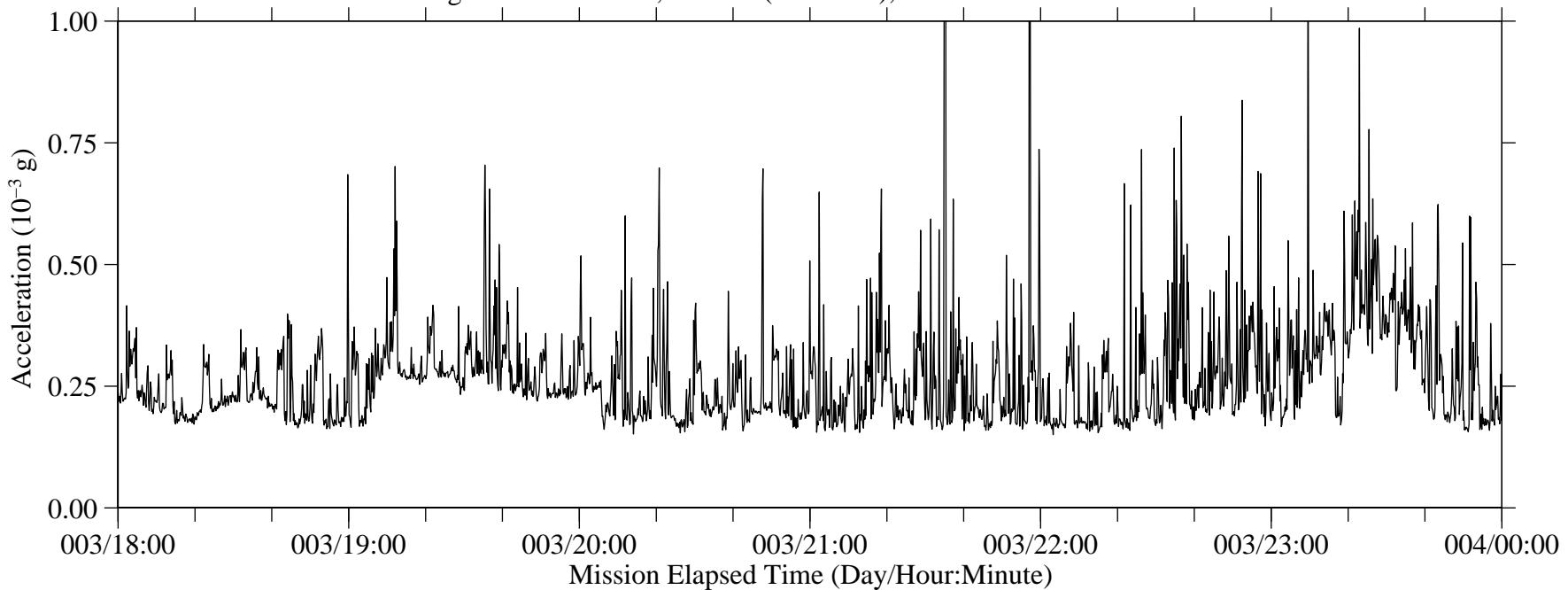


Figure 26: STS-79, Head C (fc=25 Hz)

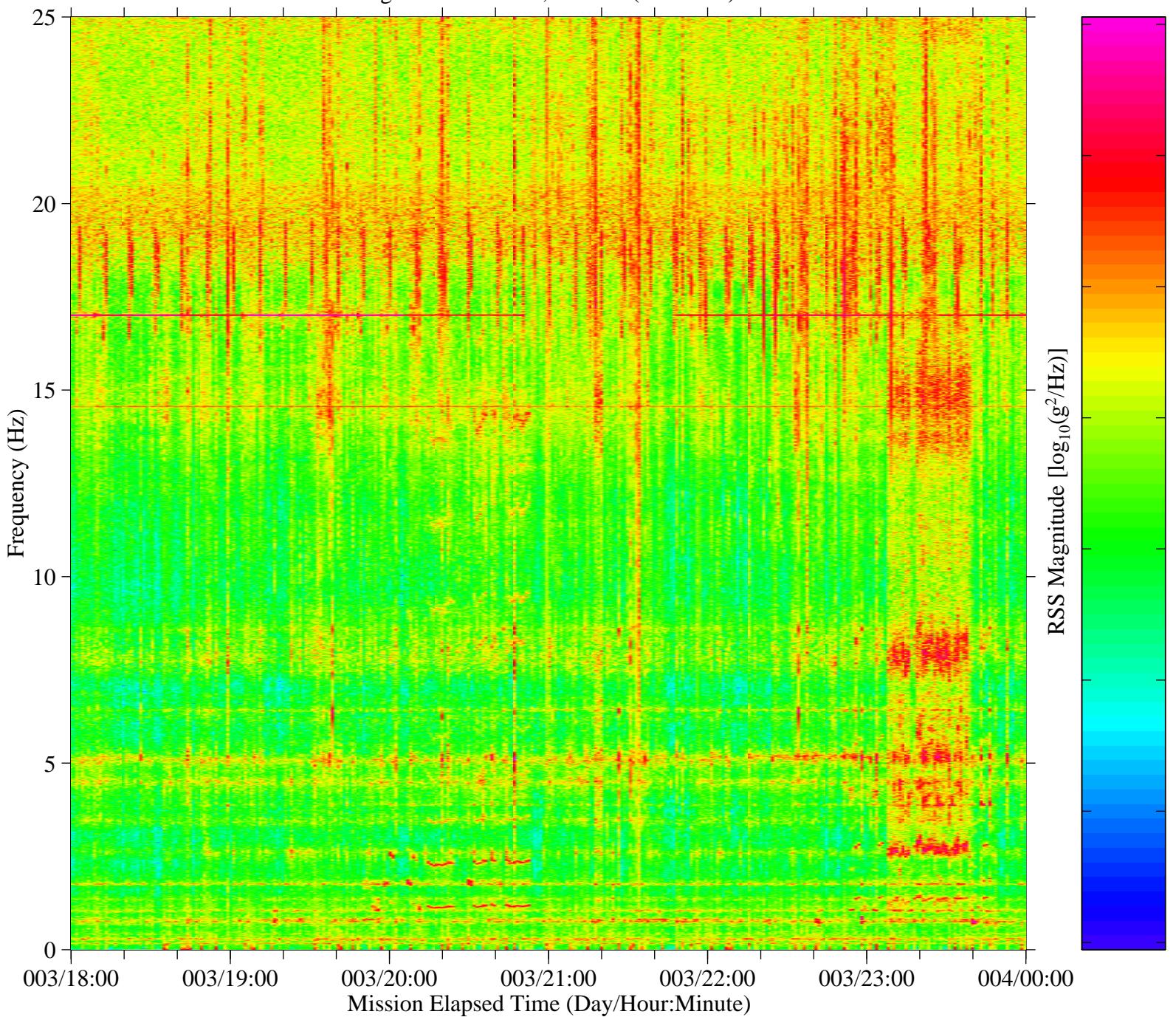


Figure 27a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

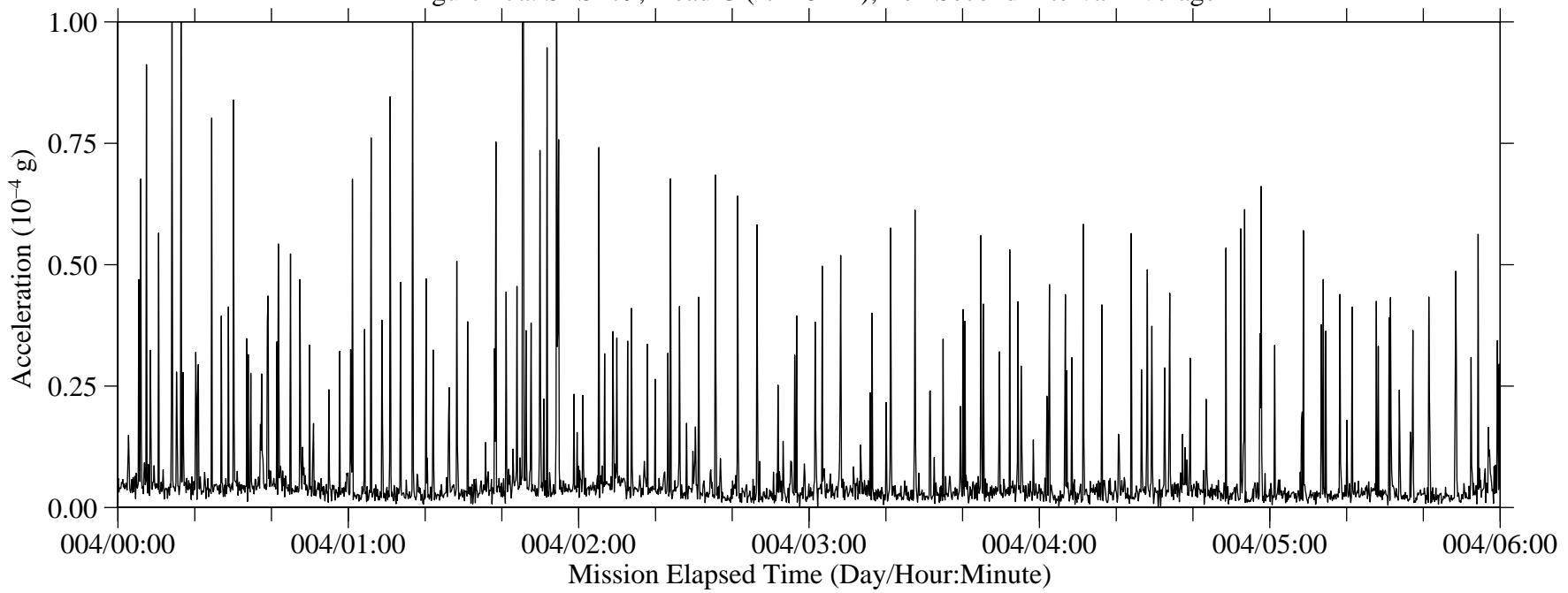


Figure 27b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

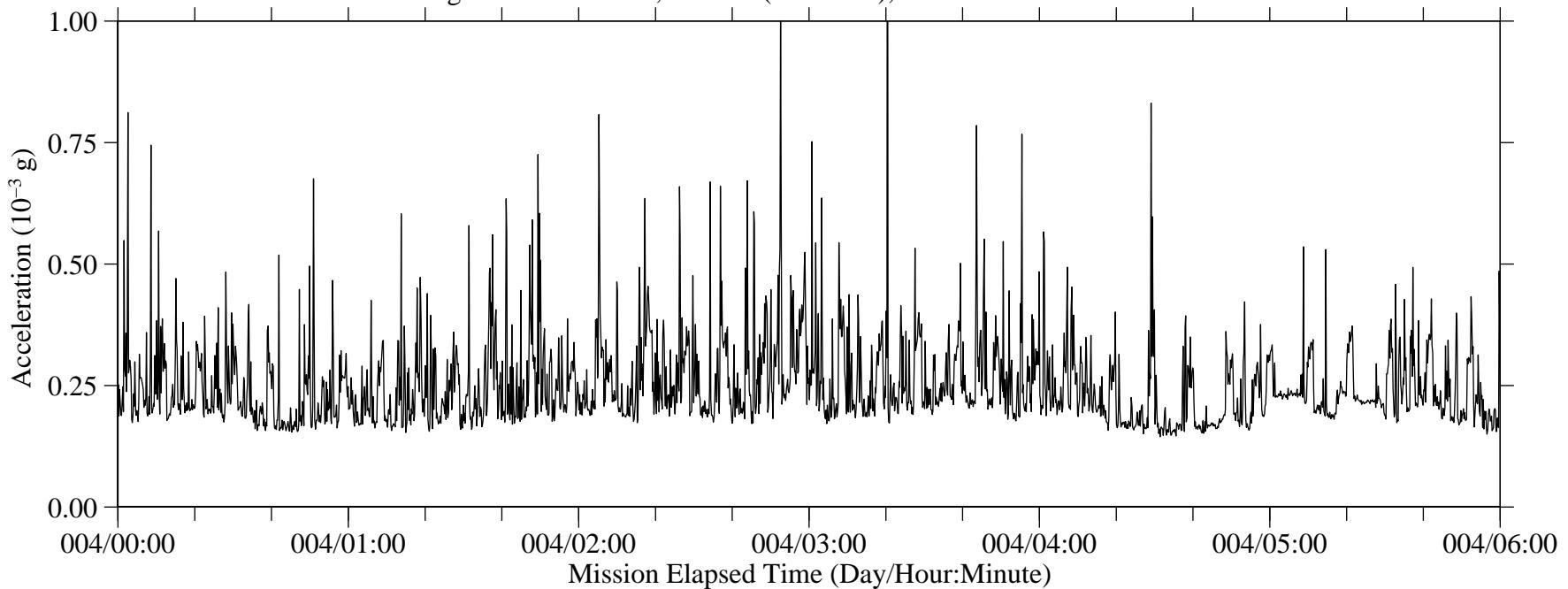


Figure 28: STS-79, Head C (fc=25 Hz)

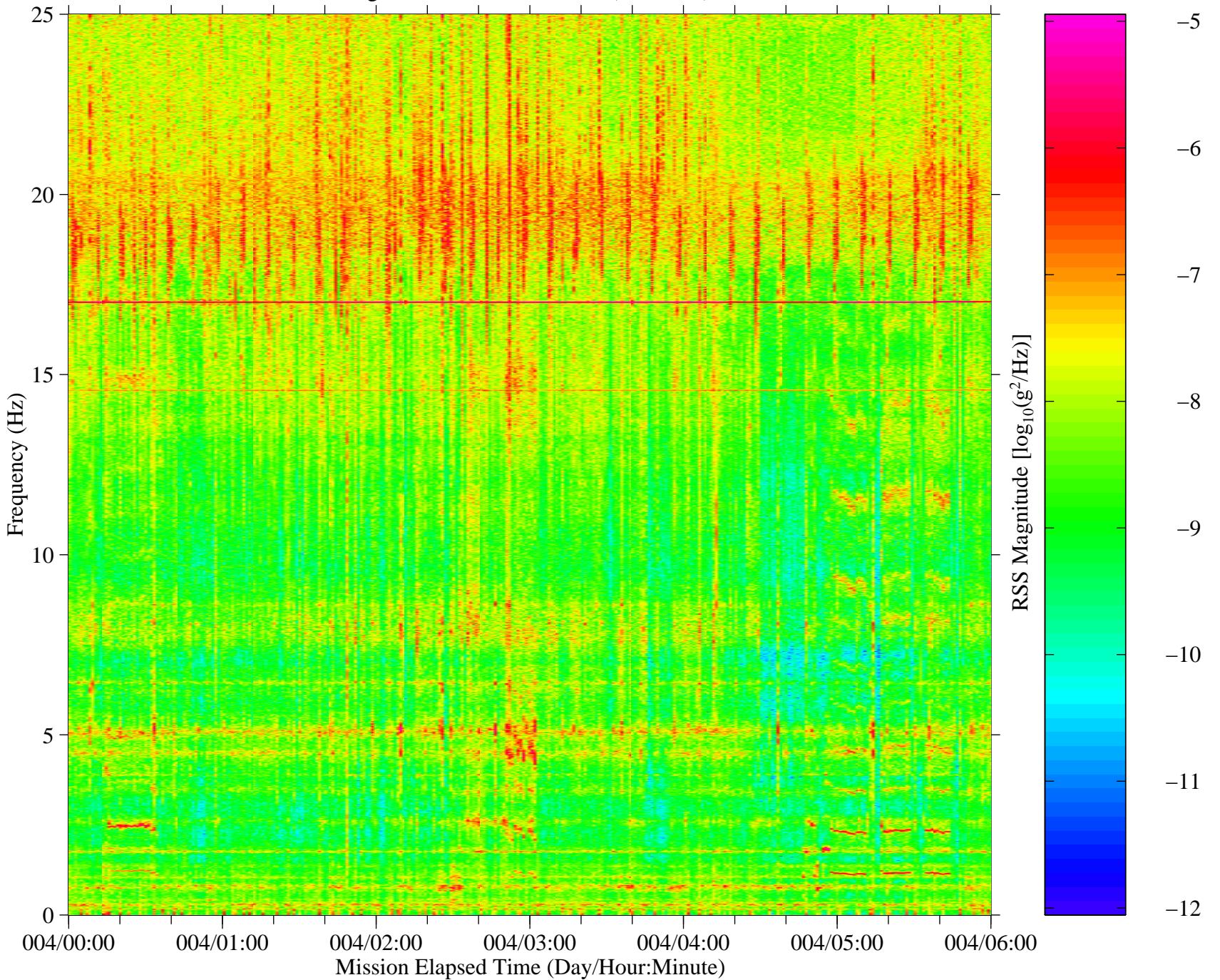
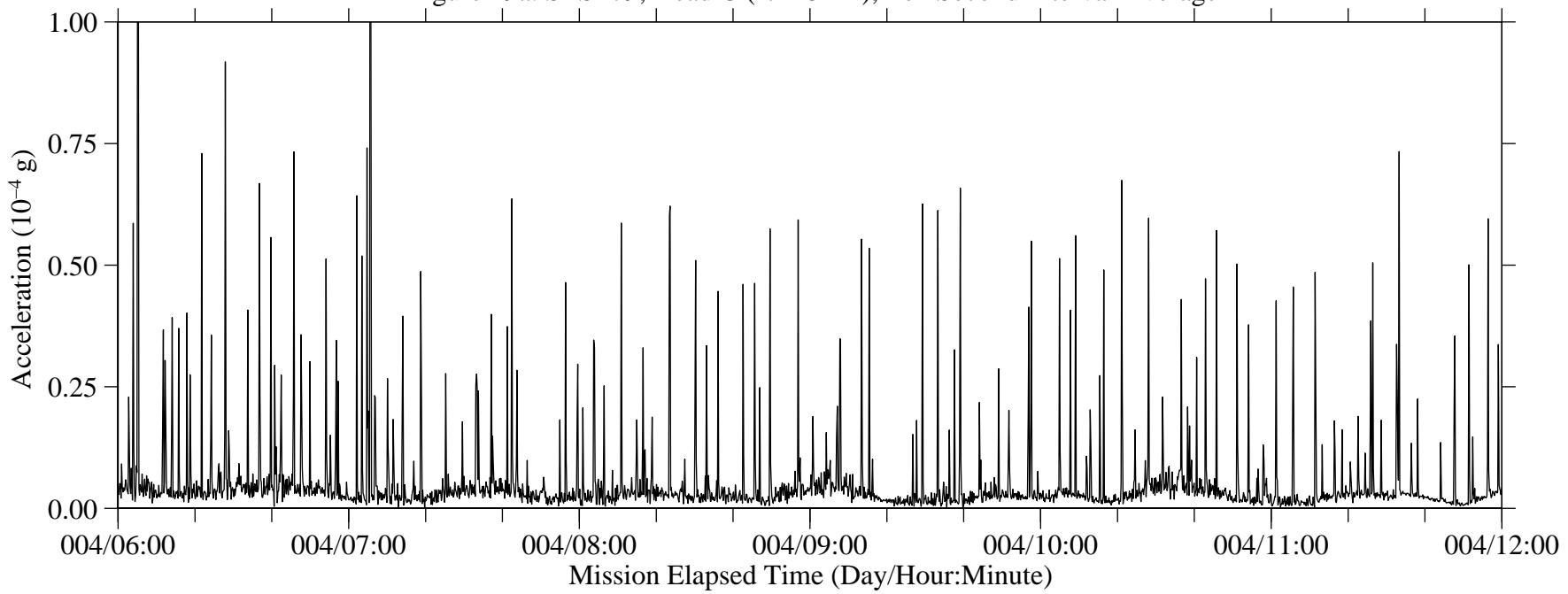


Figure 29a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-32

Figure 29b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

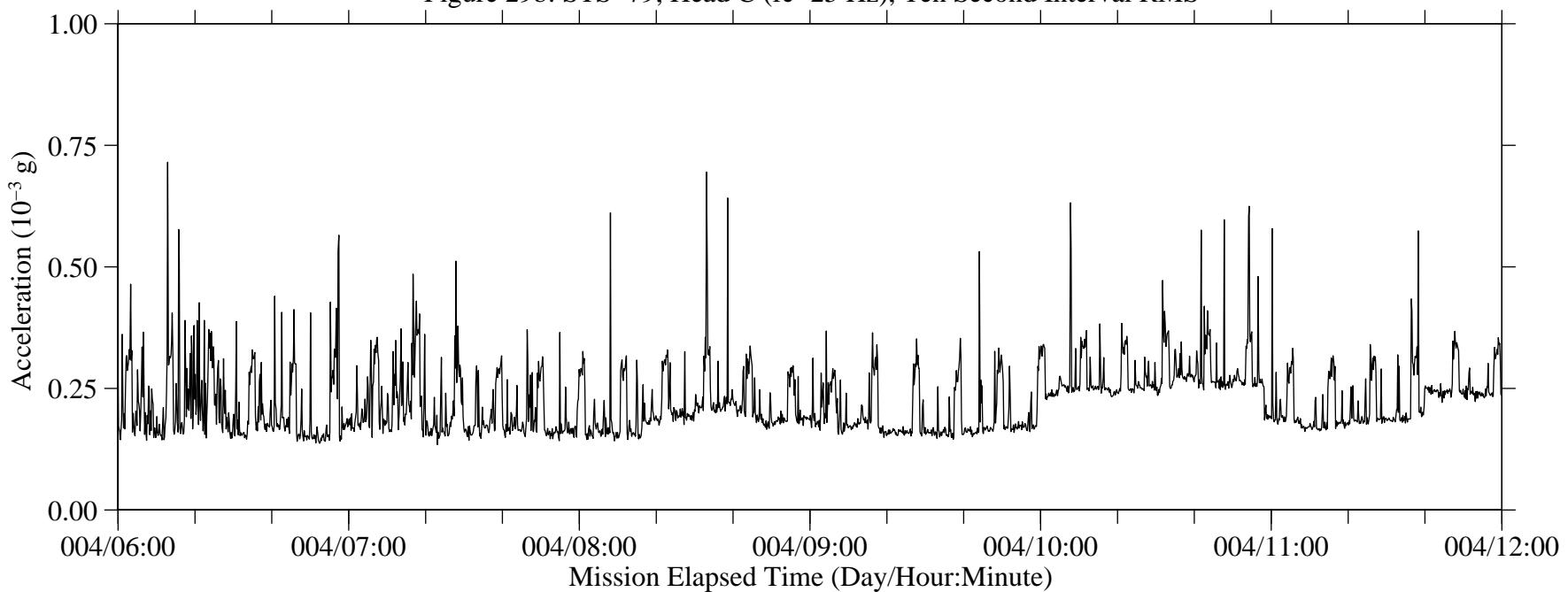


Figure 30: STS-79, Head C (fc=25 Hz)

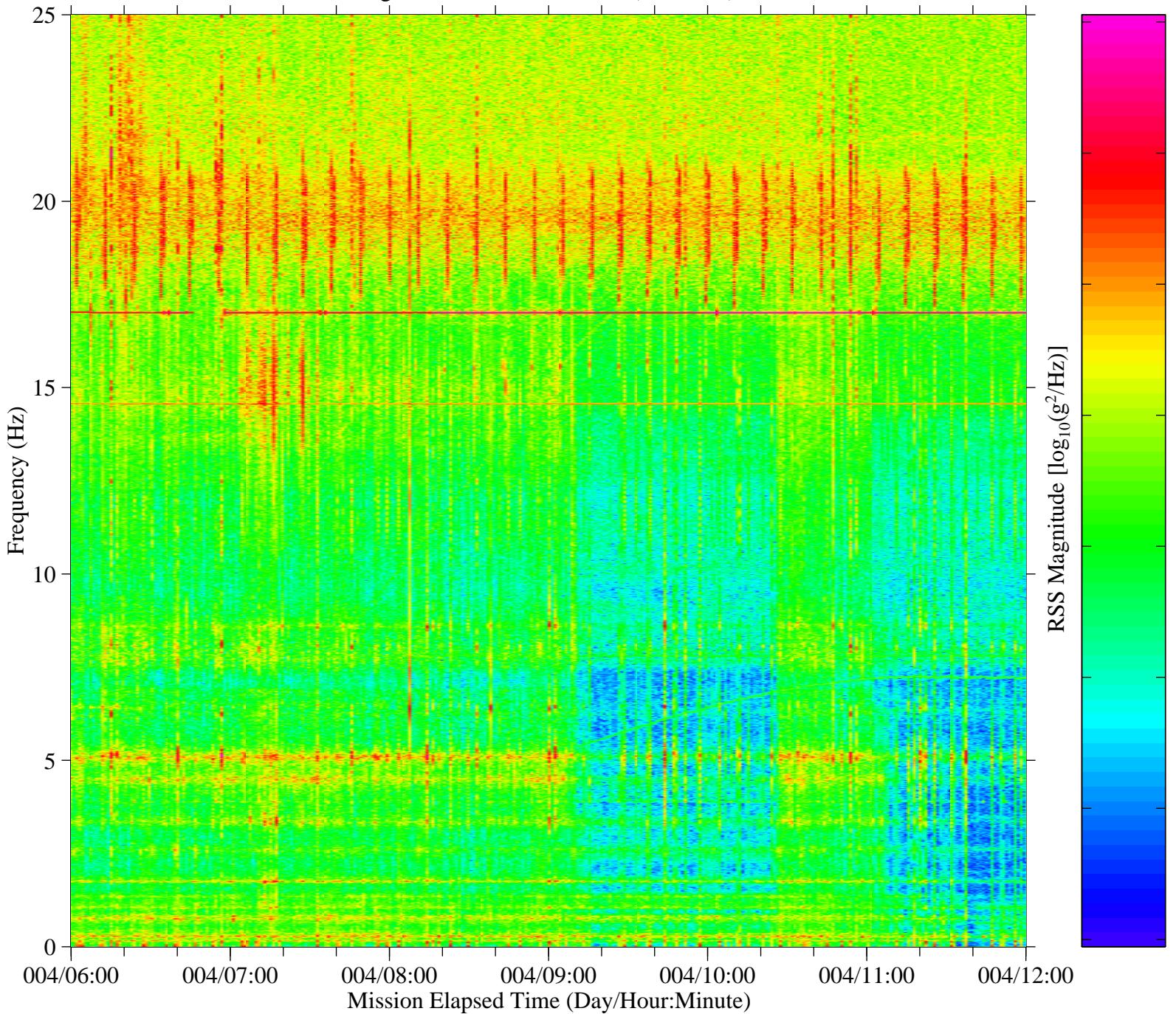


Figure 31a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

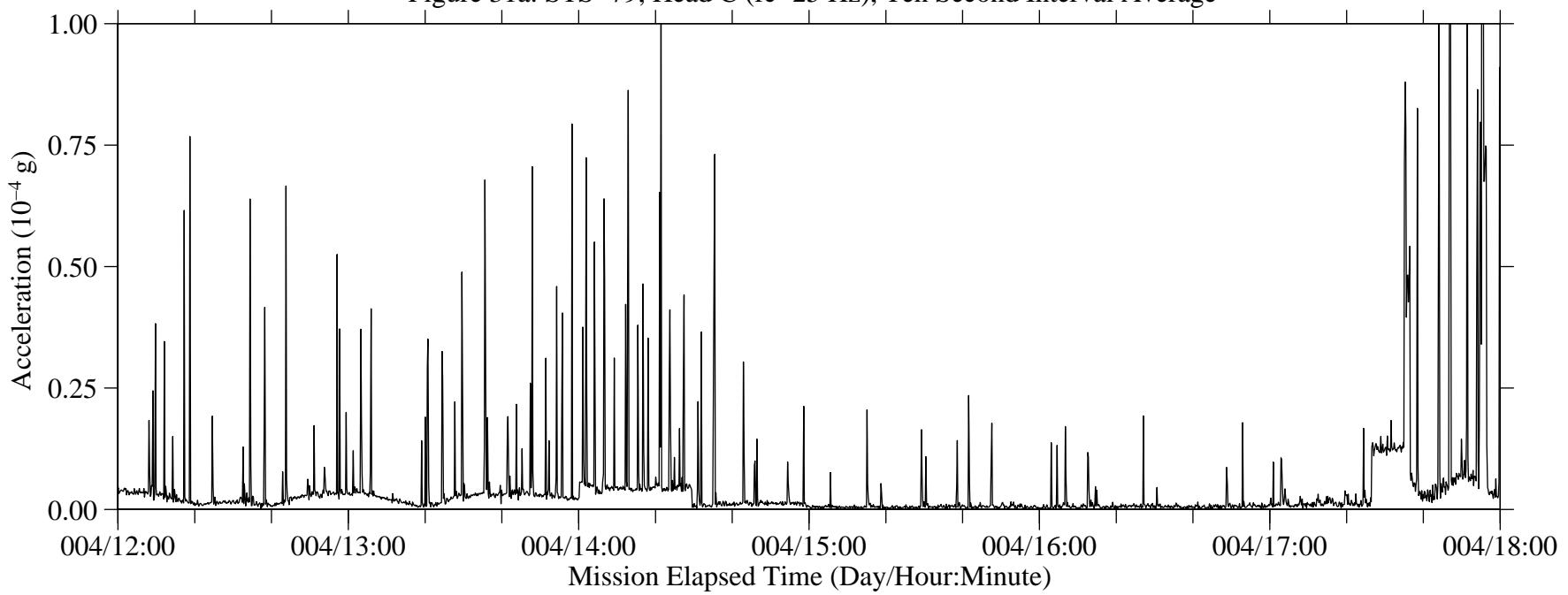


Figure 31b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

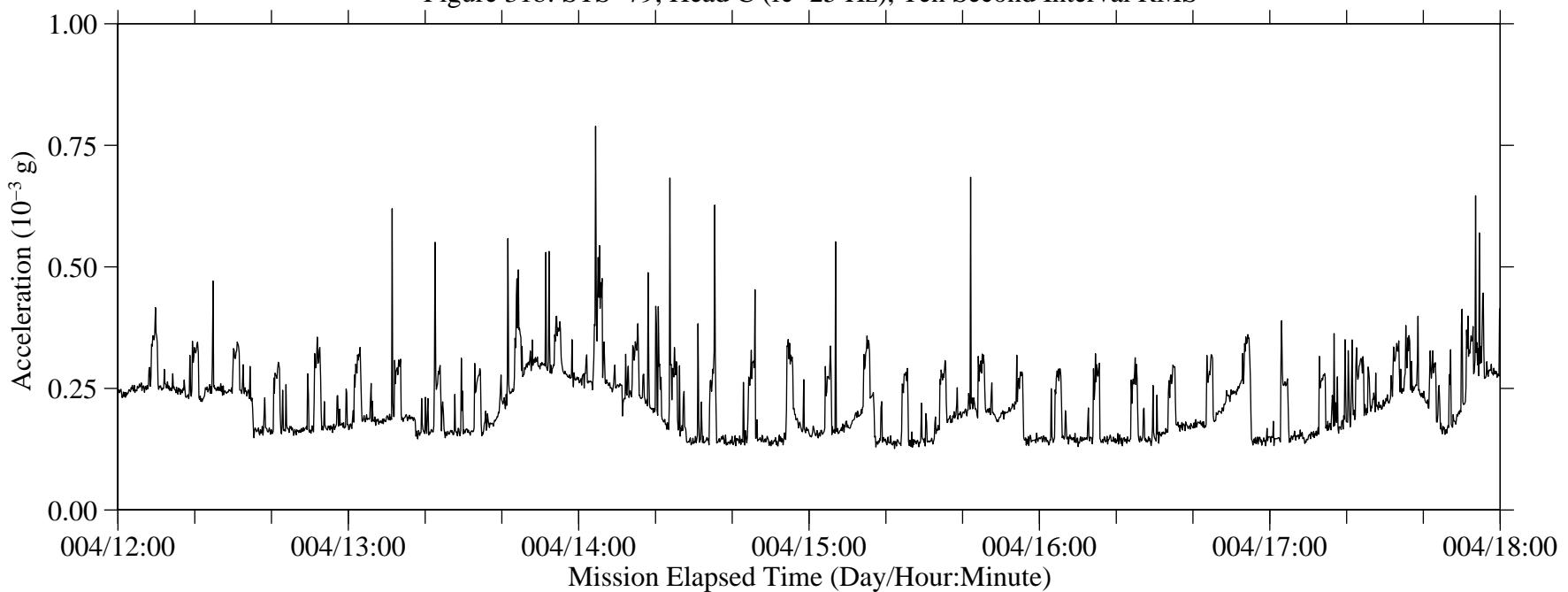


Figure 32: STS-79, Head C (fc=25 Hz)

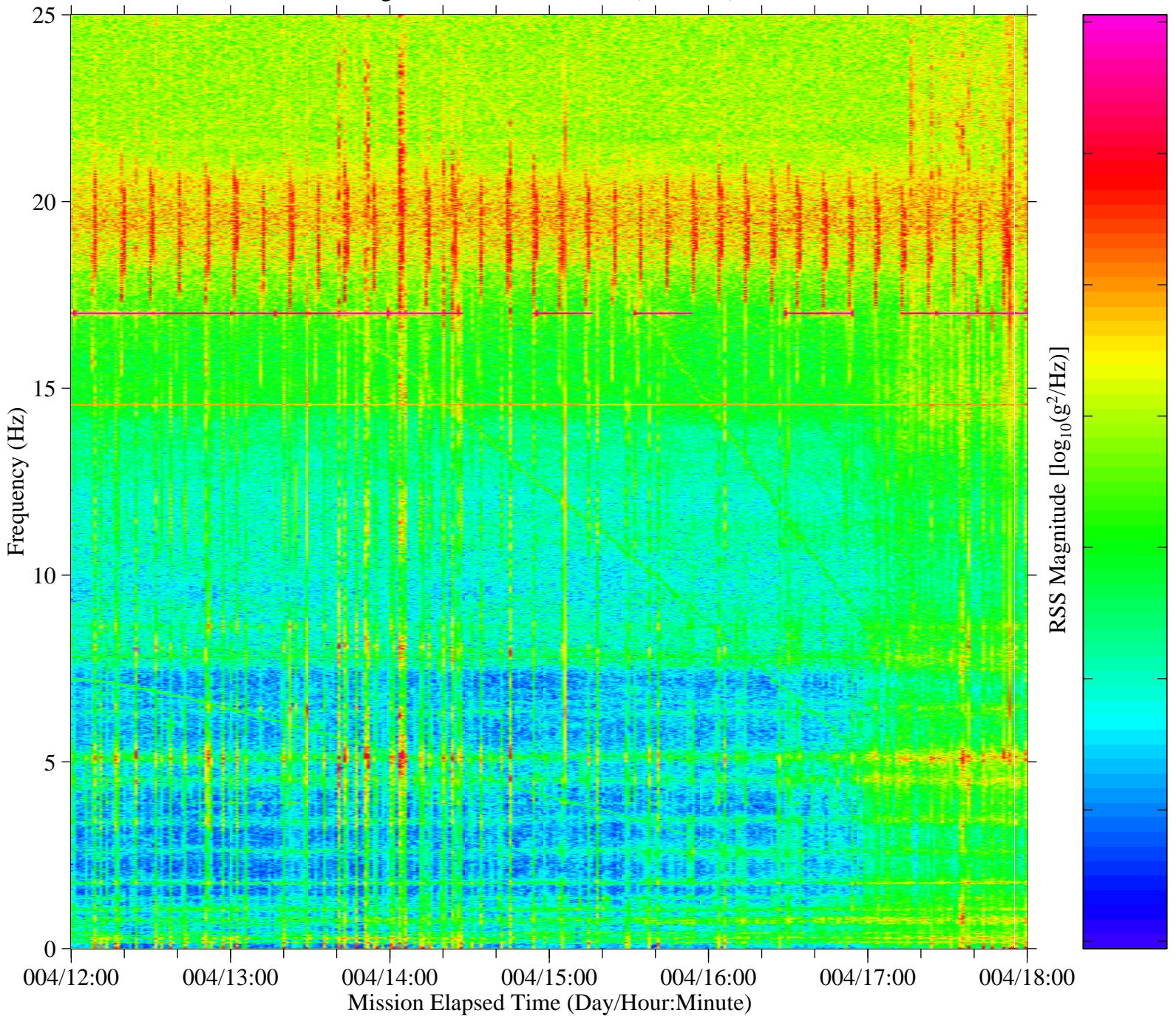


Figure 33a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

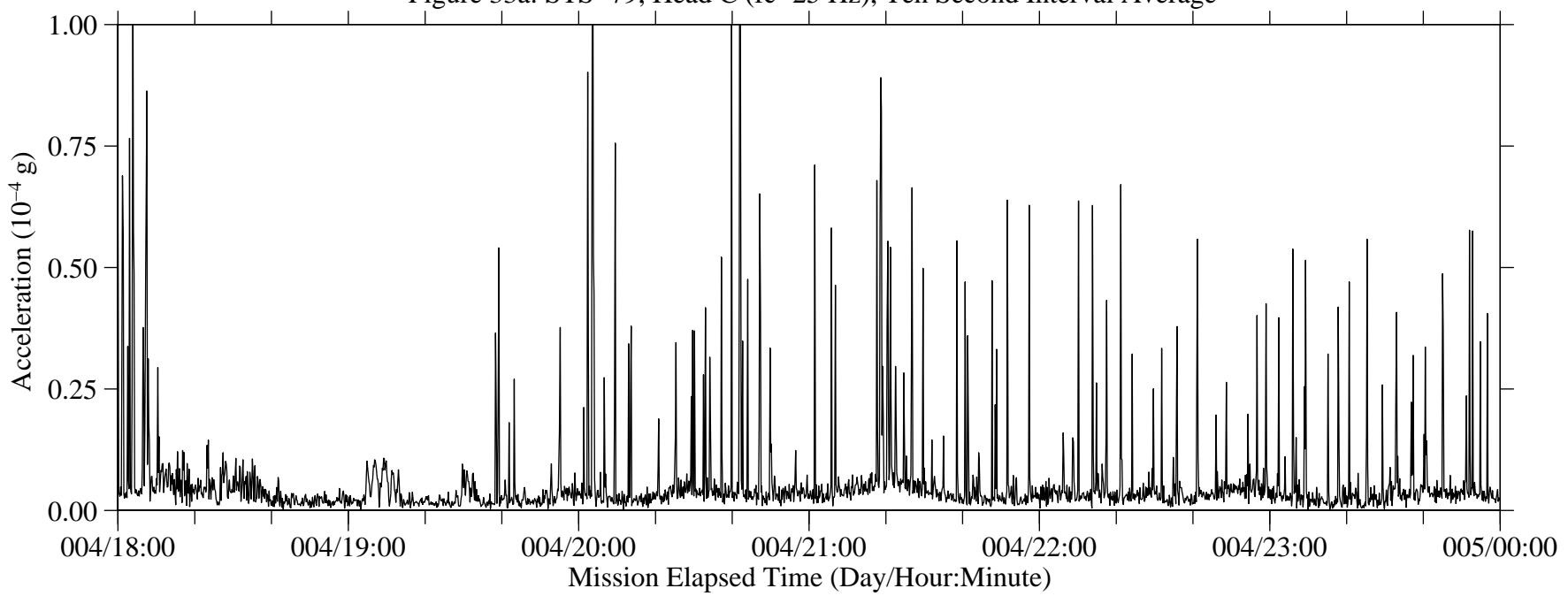


Figure 33b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

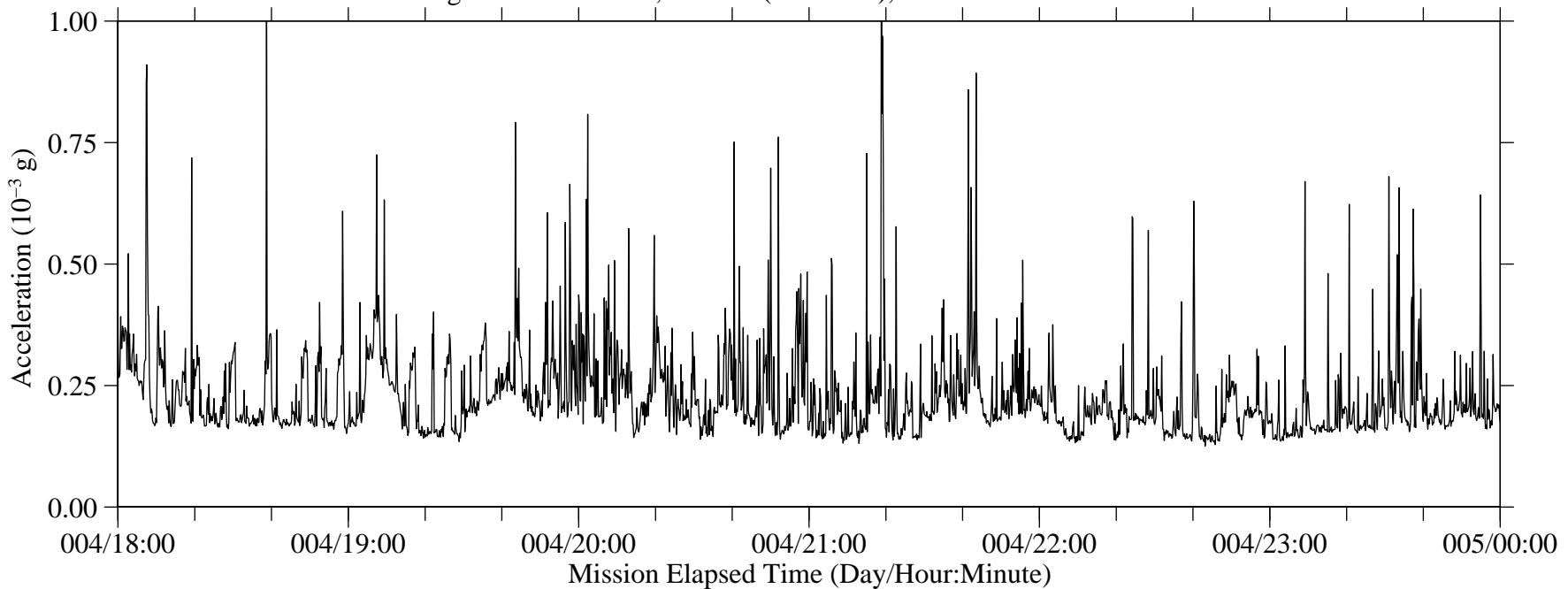


Figure 34: STS-79, Head C (fc=25 Hz)

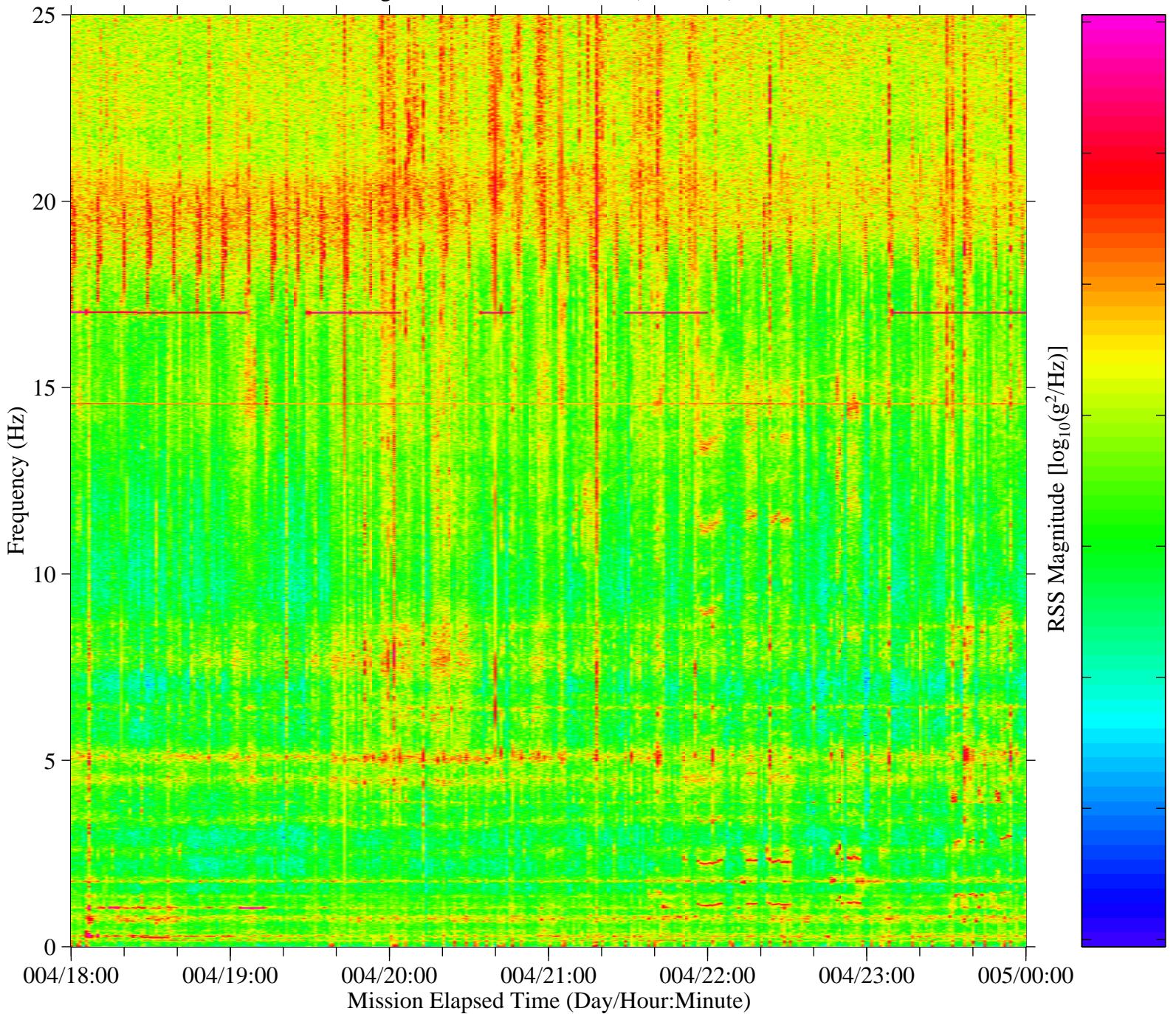


Figure 35a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

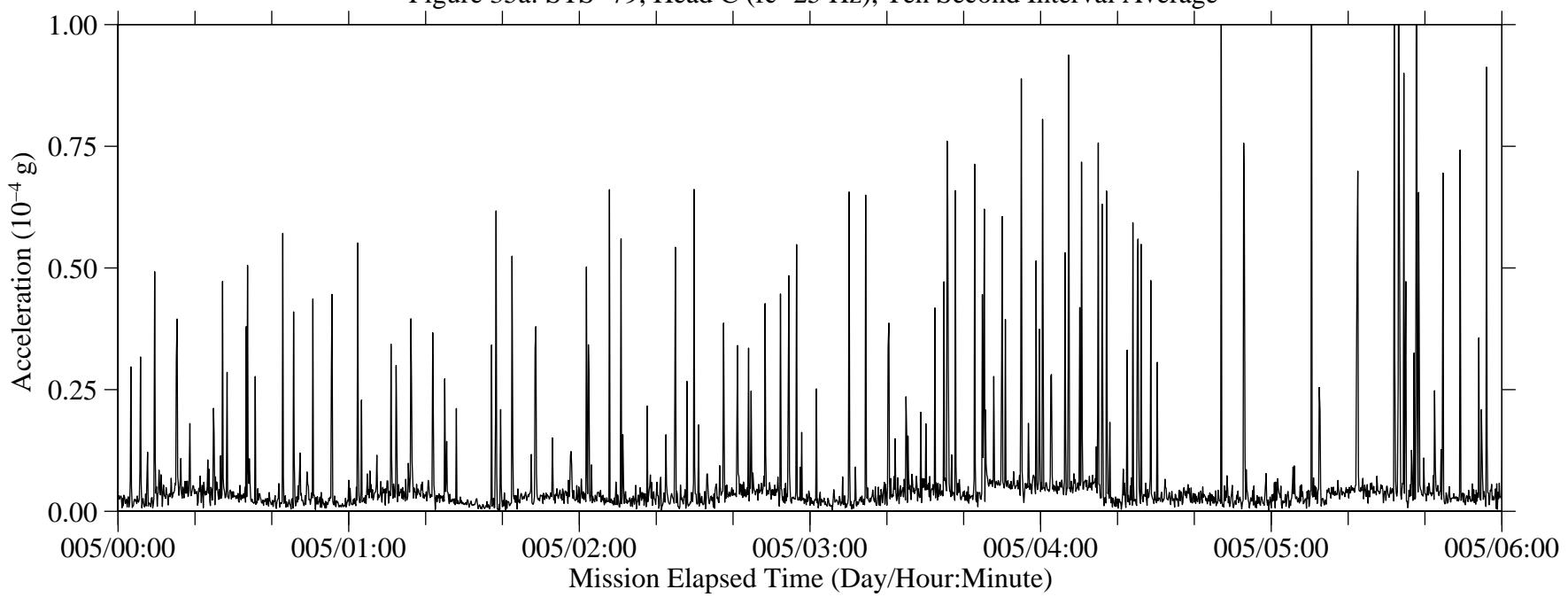


Figure 35b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

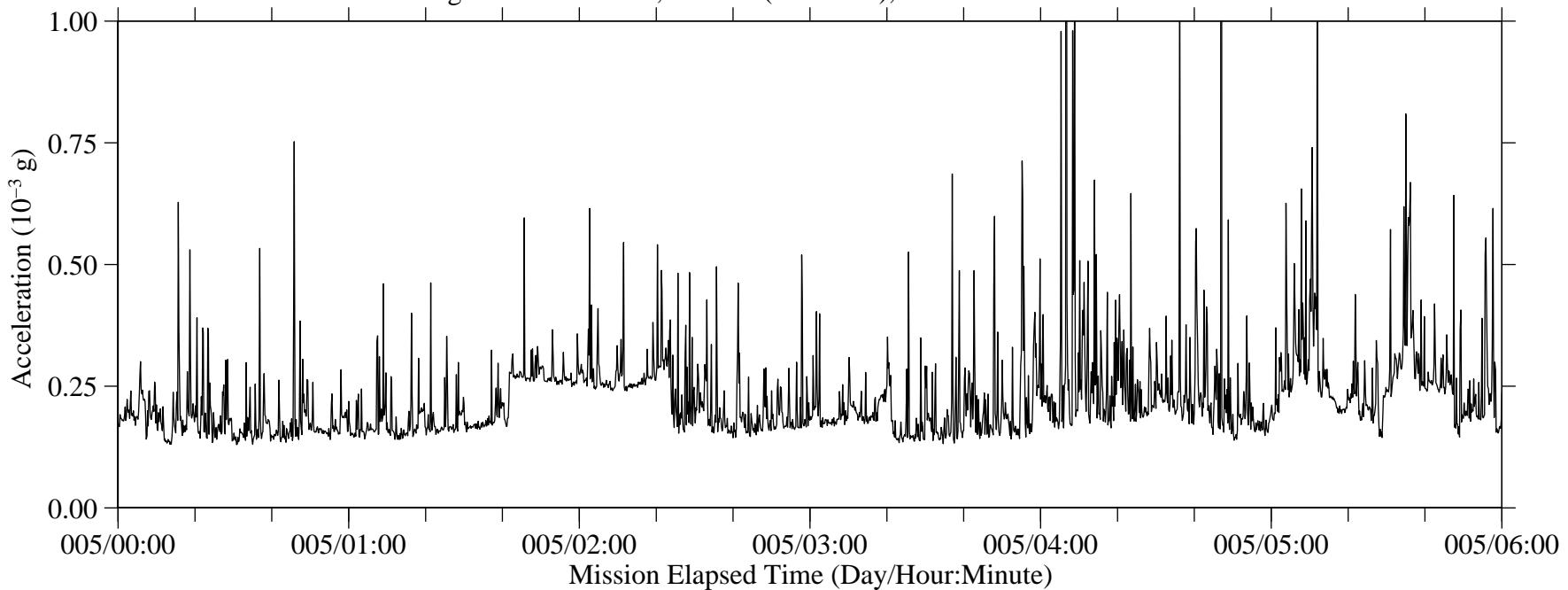


Figure 36: STS-79, Head C (fc=25 Hz)

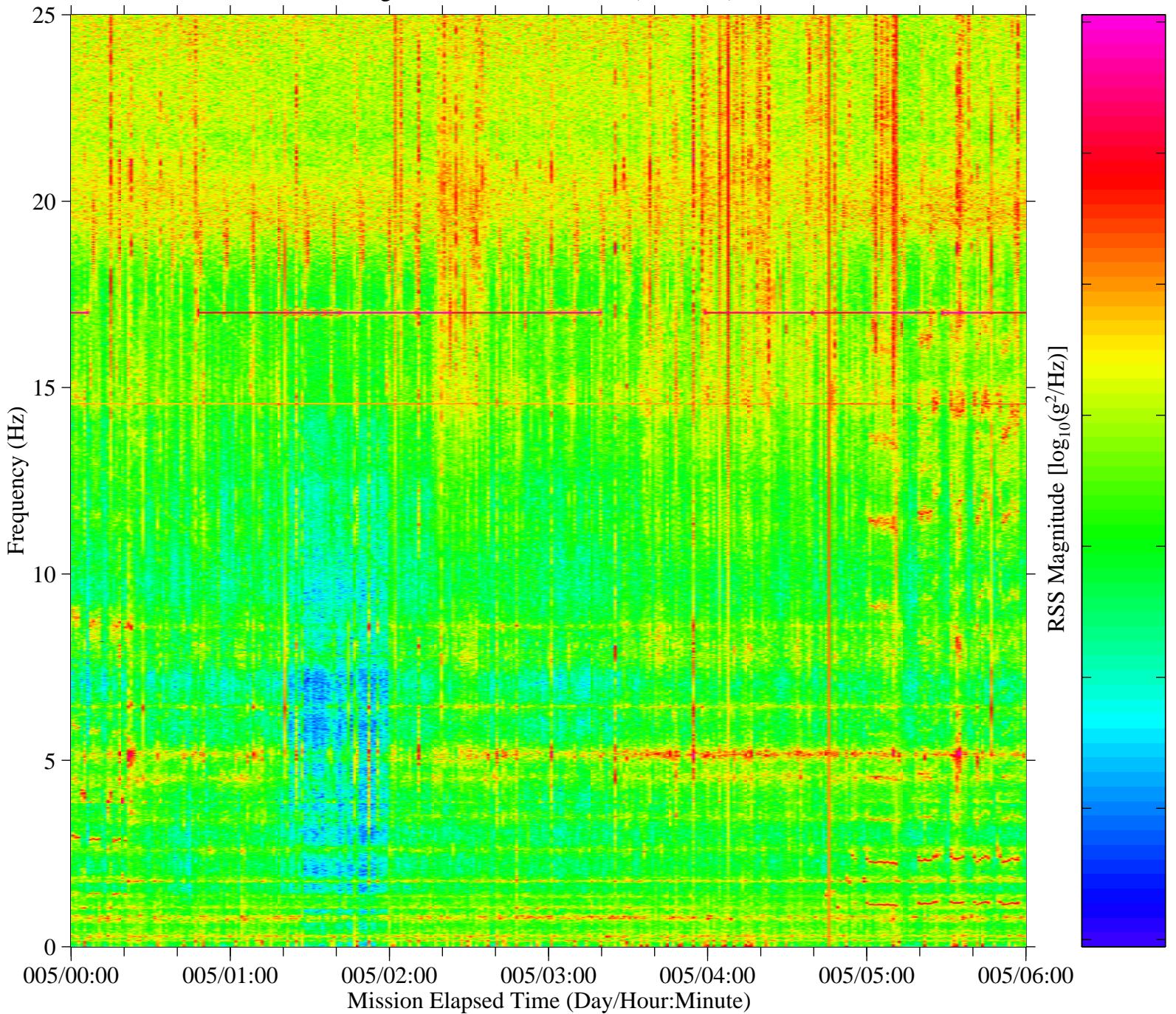


Figure 37a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

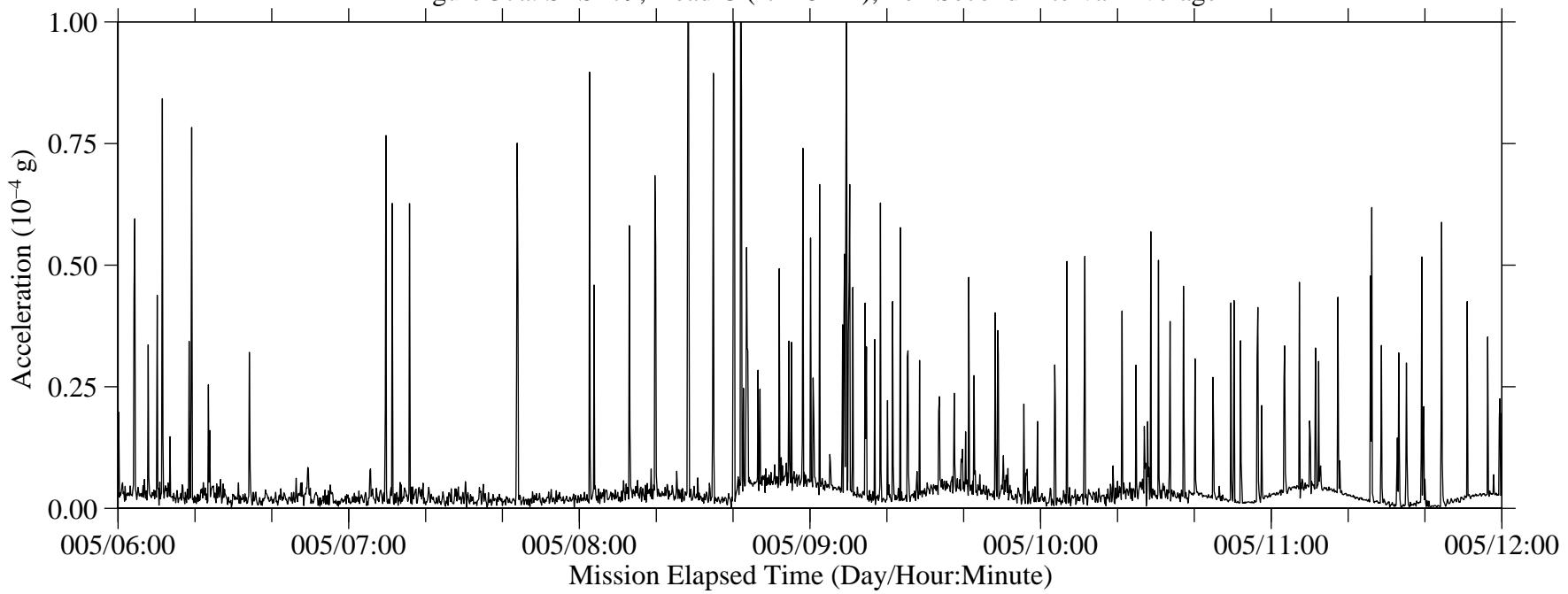


Figure 37b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

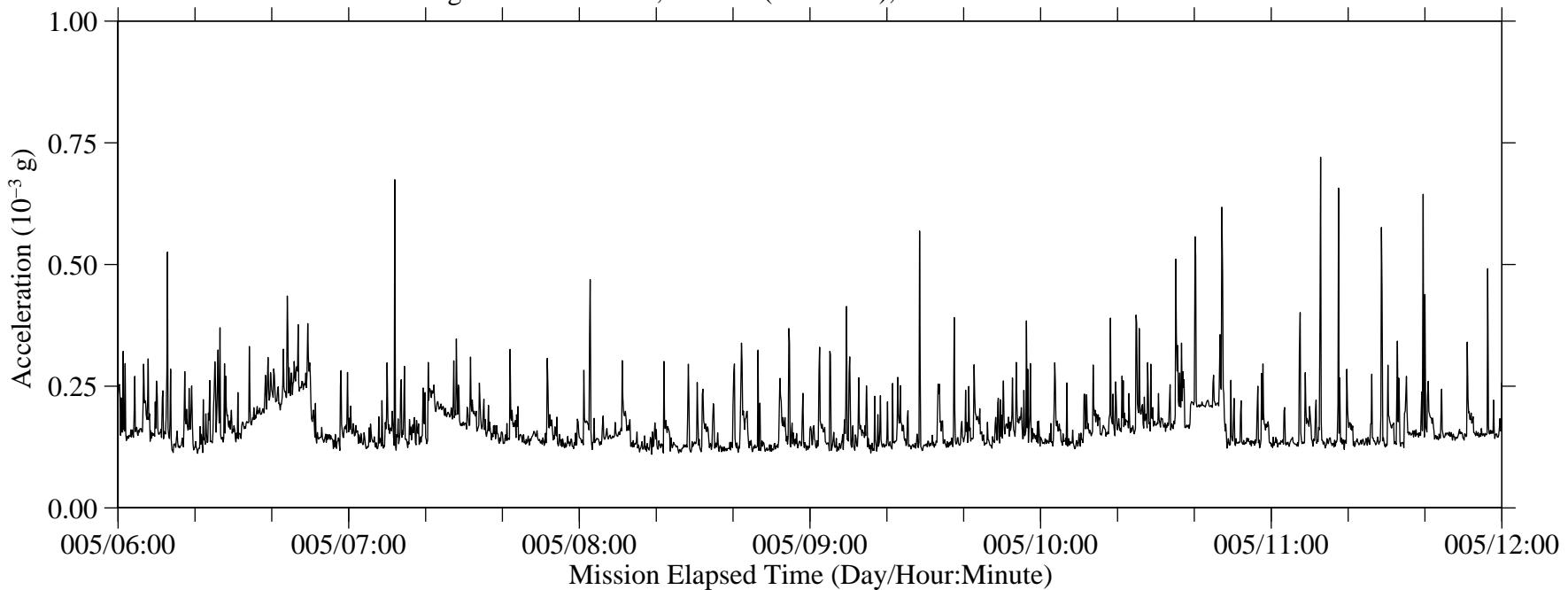


Figure 38: STS-79, Head C (fc=25 Hz)

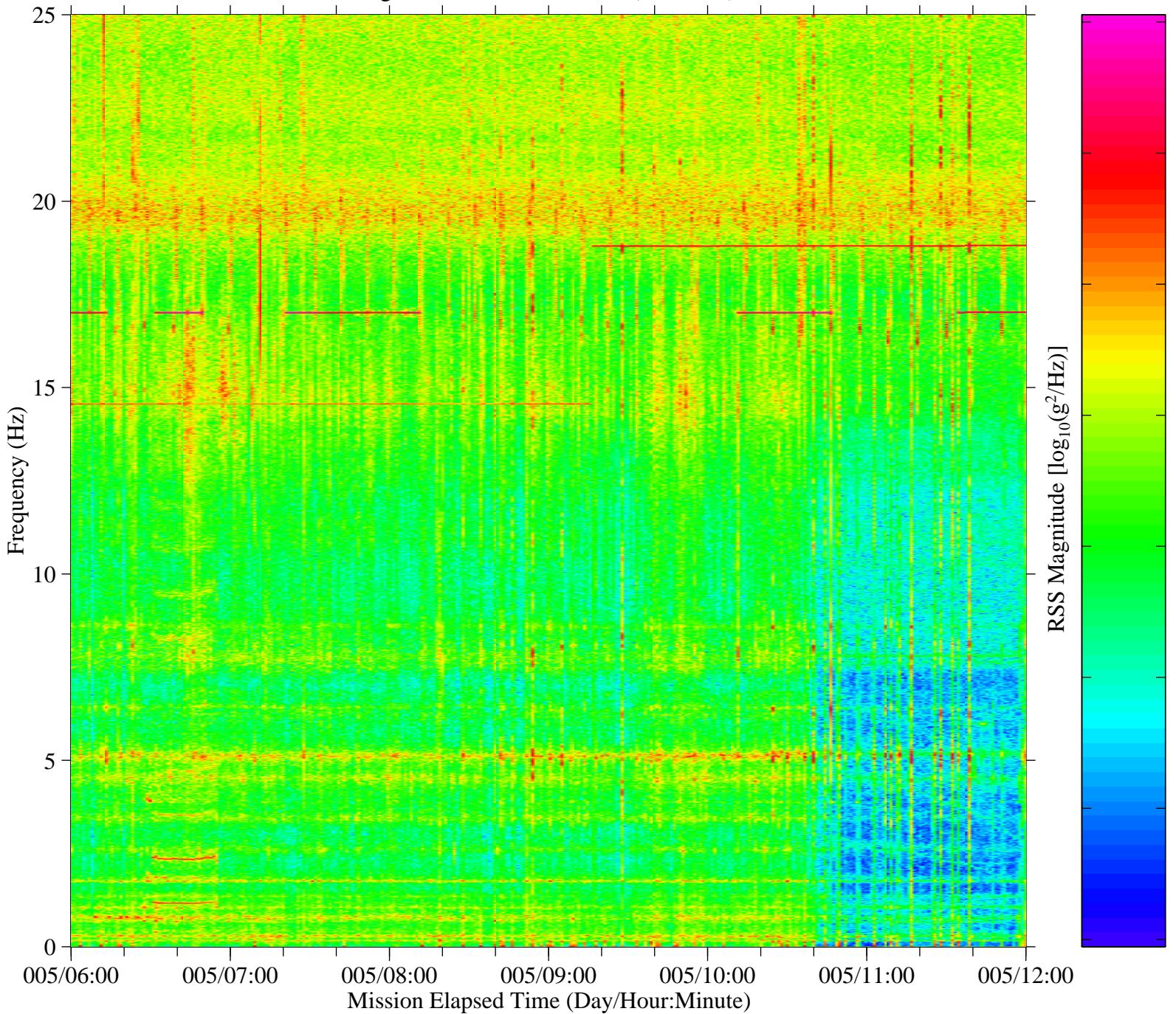


Figure 39a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

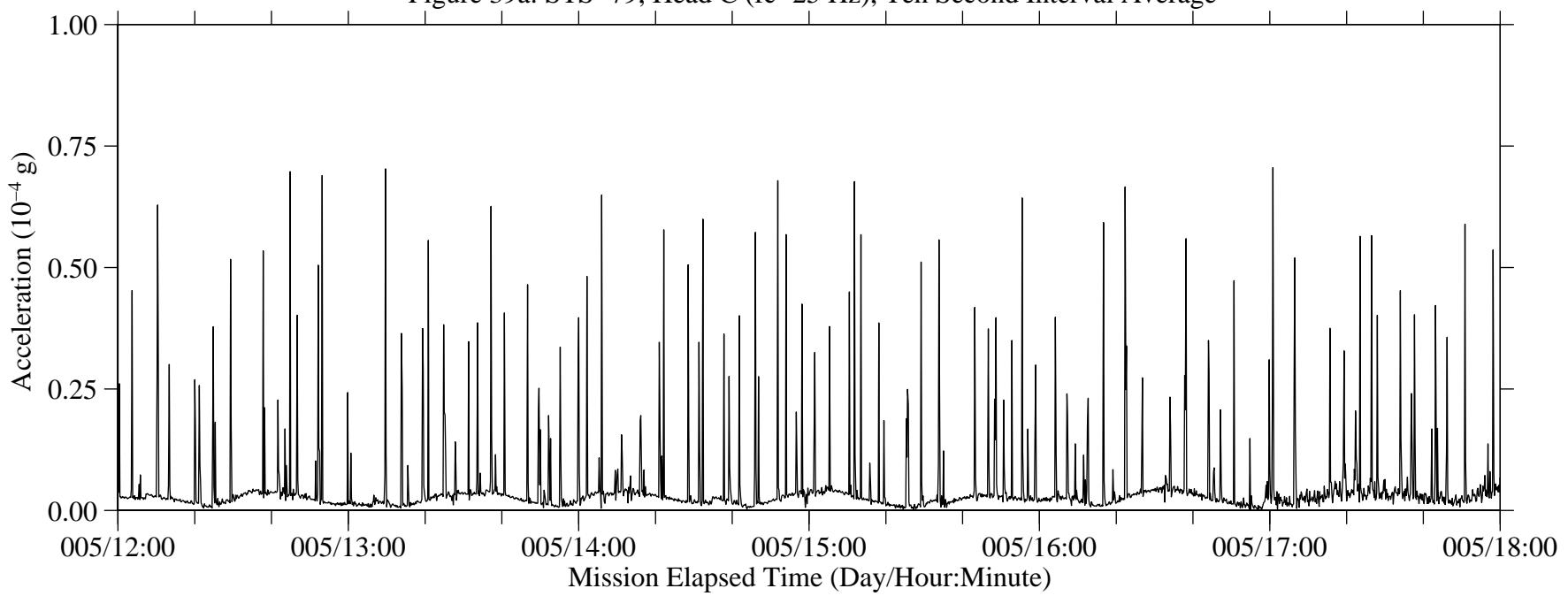


Figure 39b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

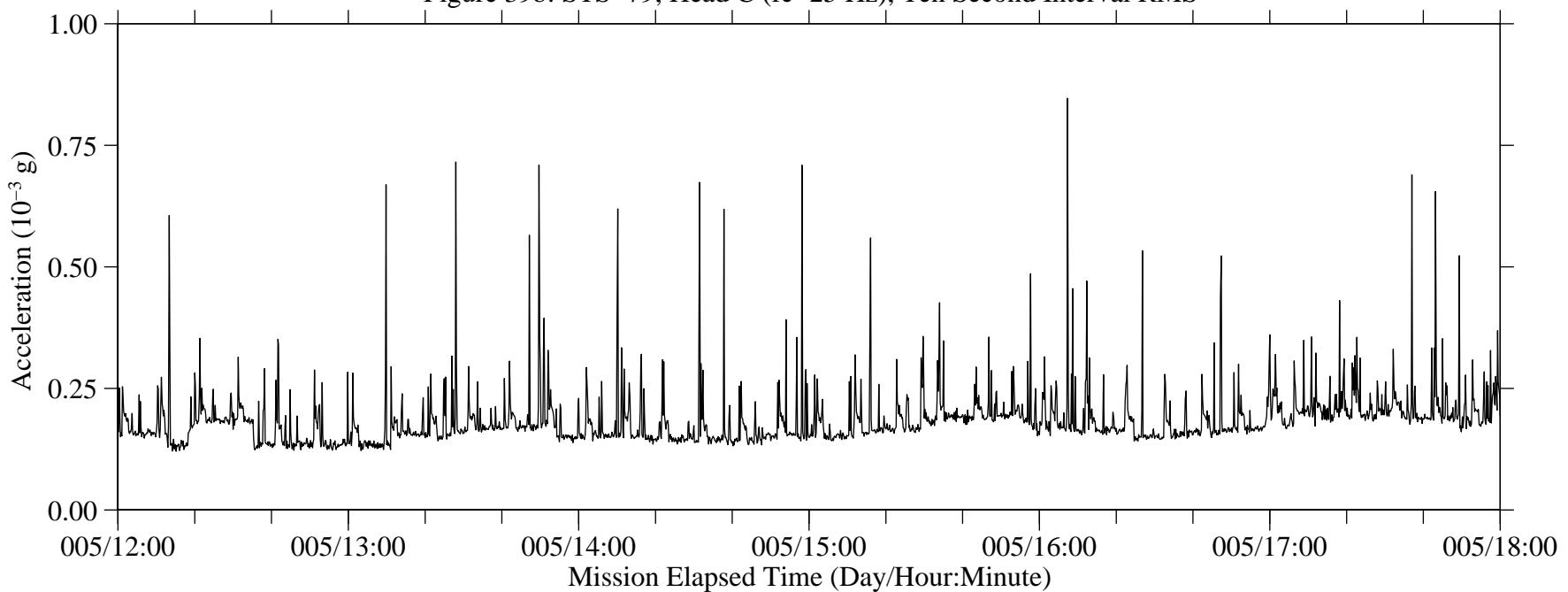


Figure 40: STS-79, Head C (fc=25 Hz)

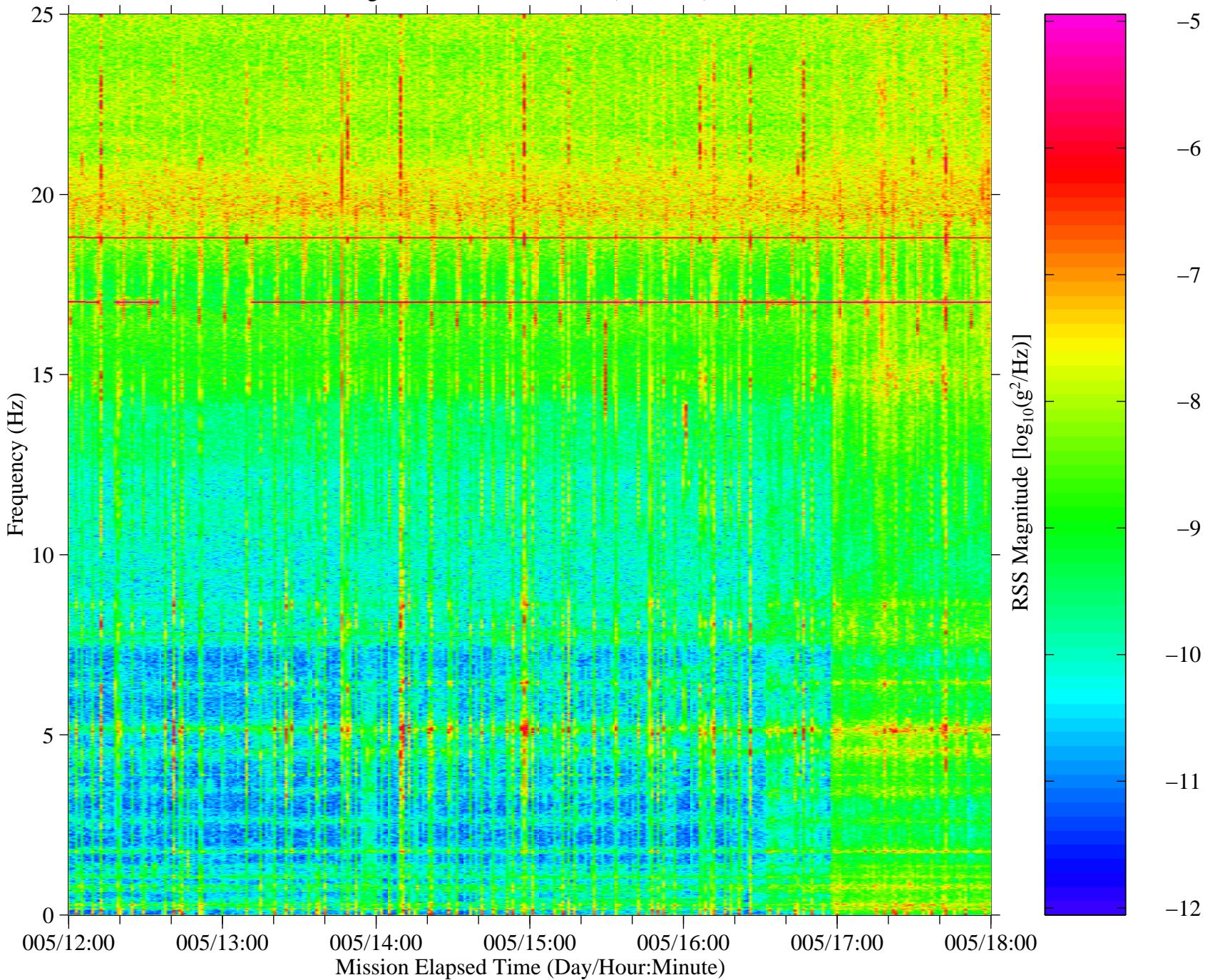
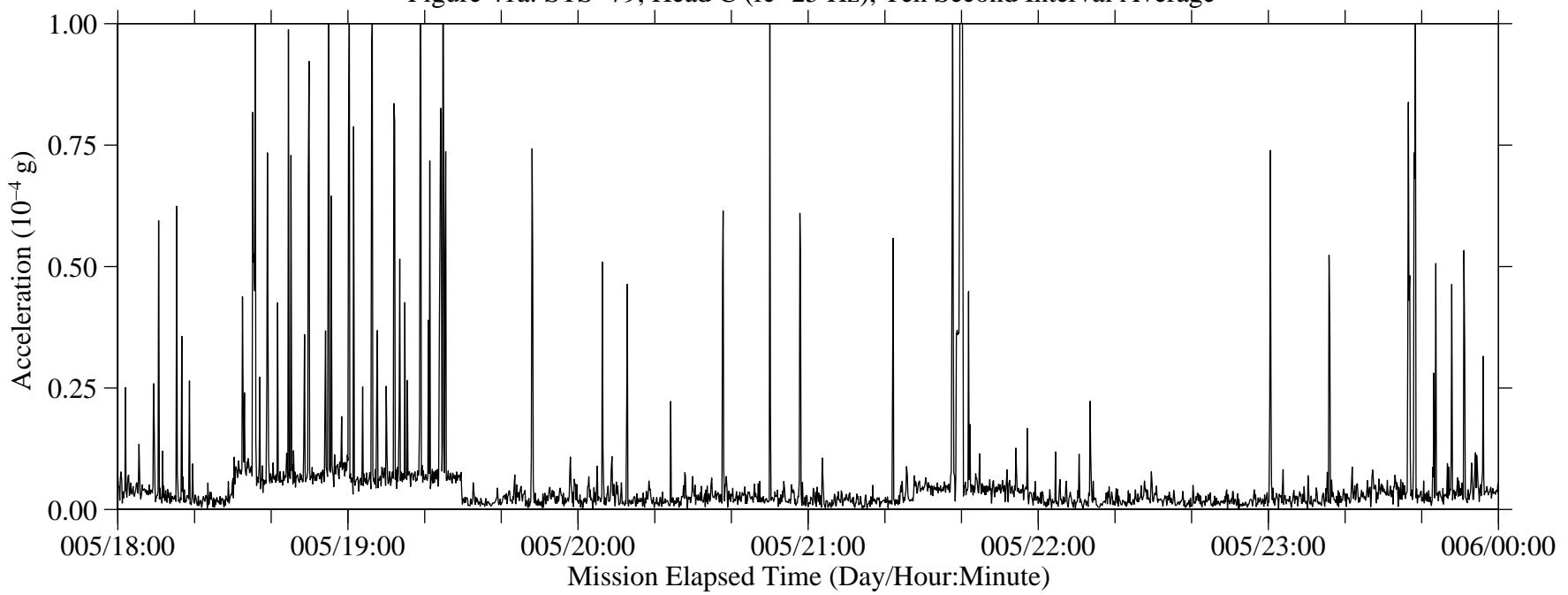


Figure 41a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-44

Figure 41b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

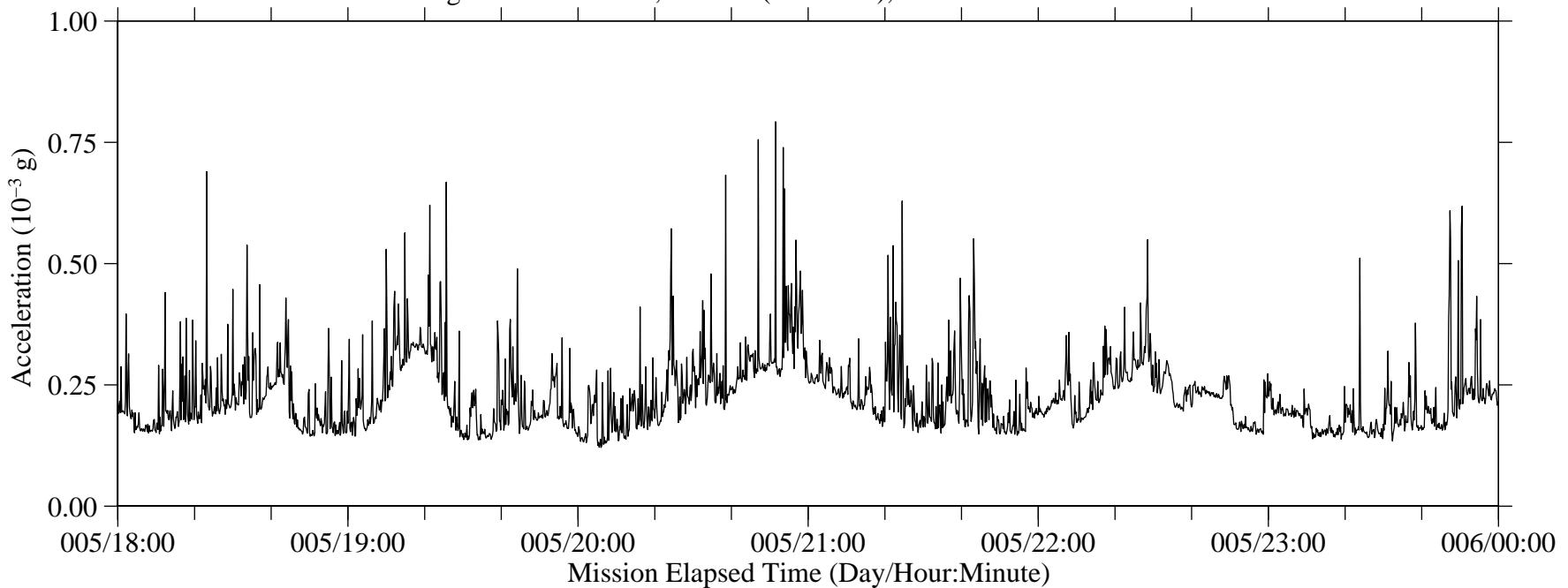


Figure 42: STS-79, Head C (fc=25 Hz)

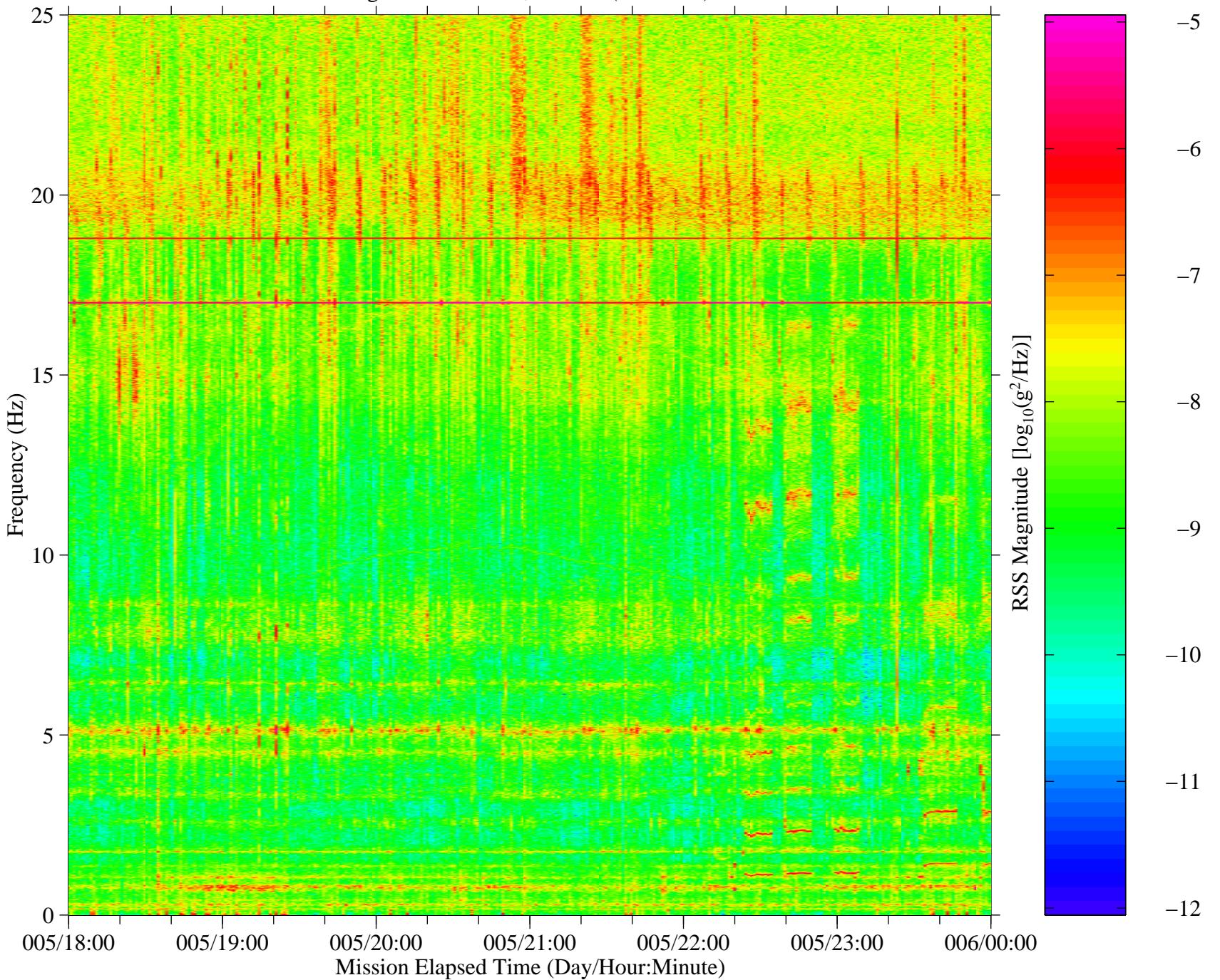


Figure 43a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

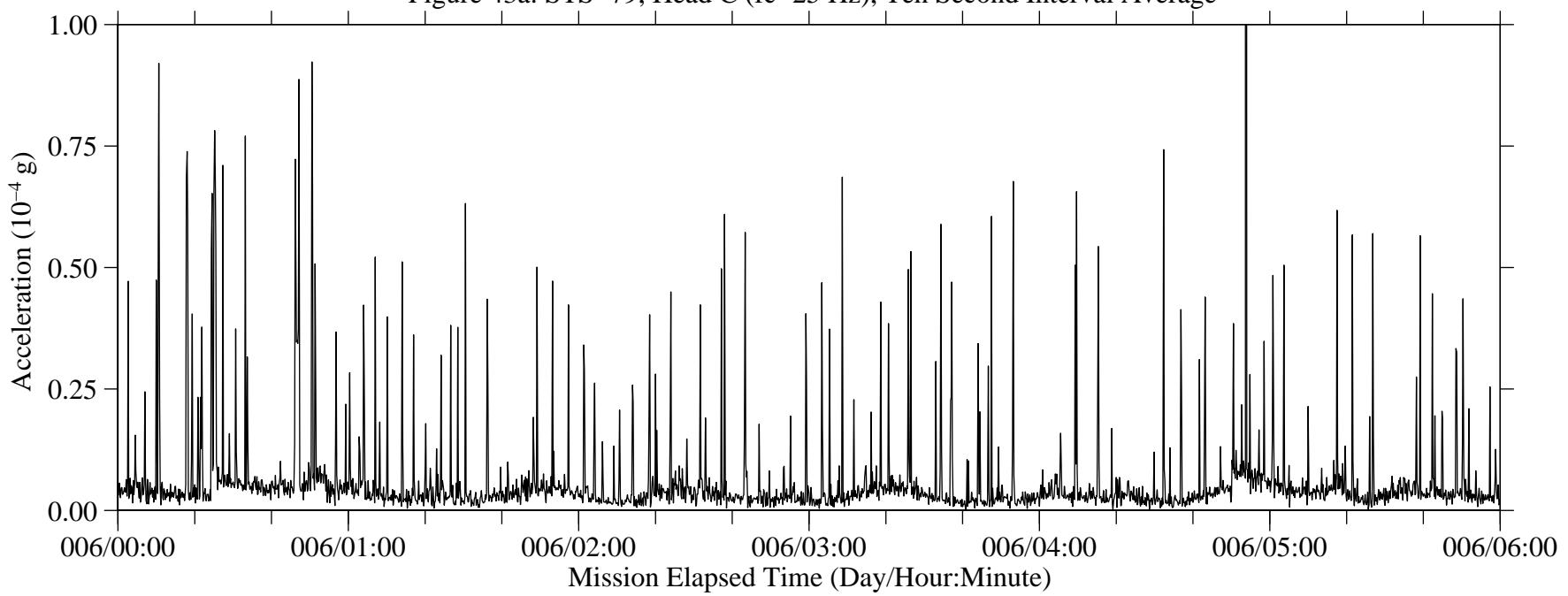


Figure 43b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

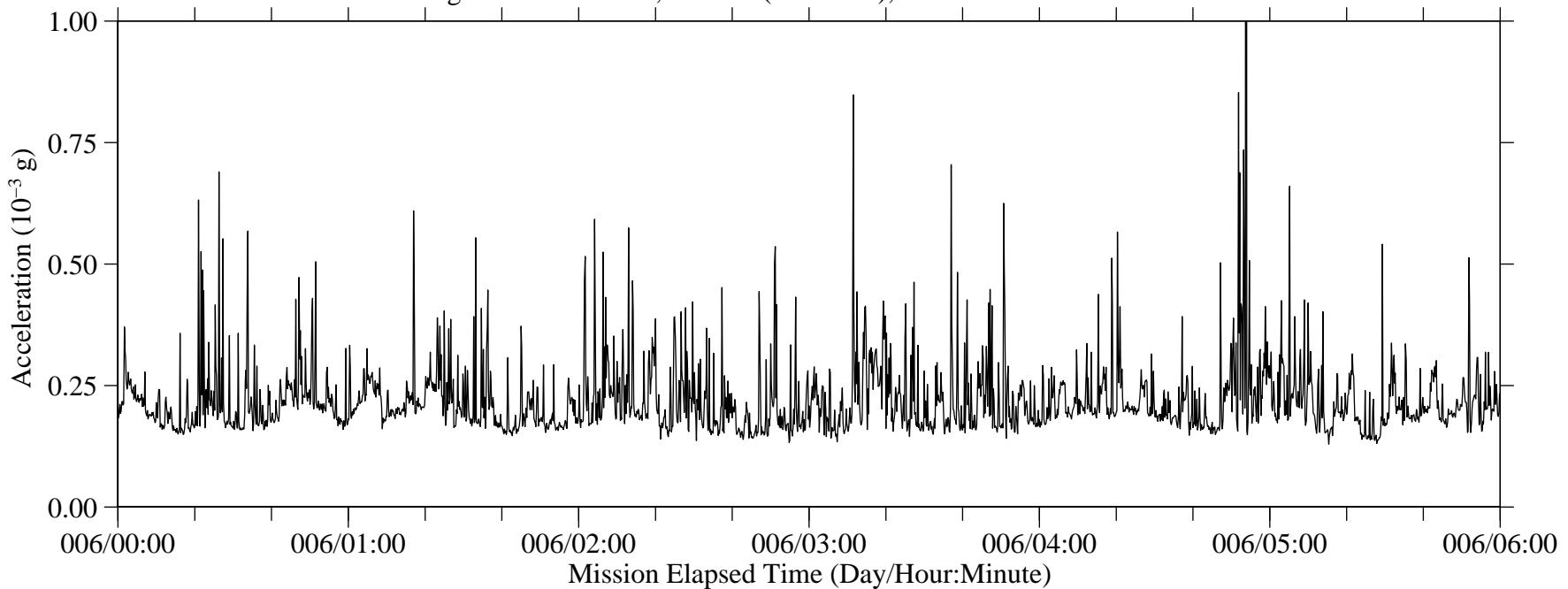


Figure 44: STS-79, Head C (fc=25 Hz)

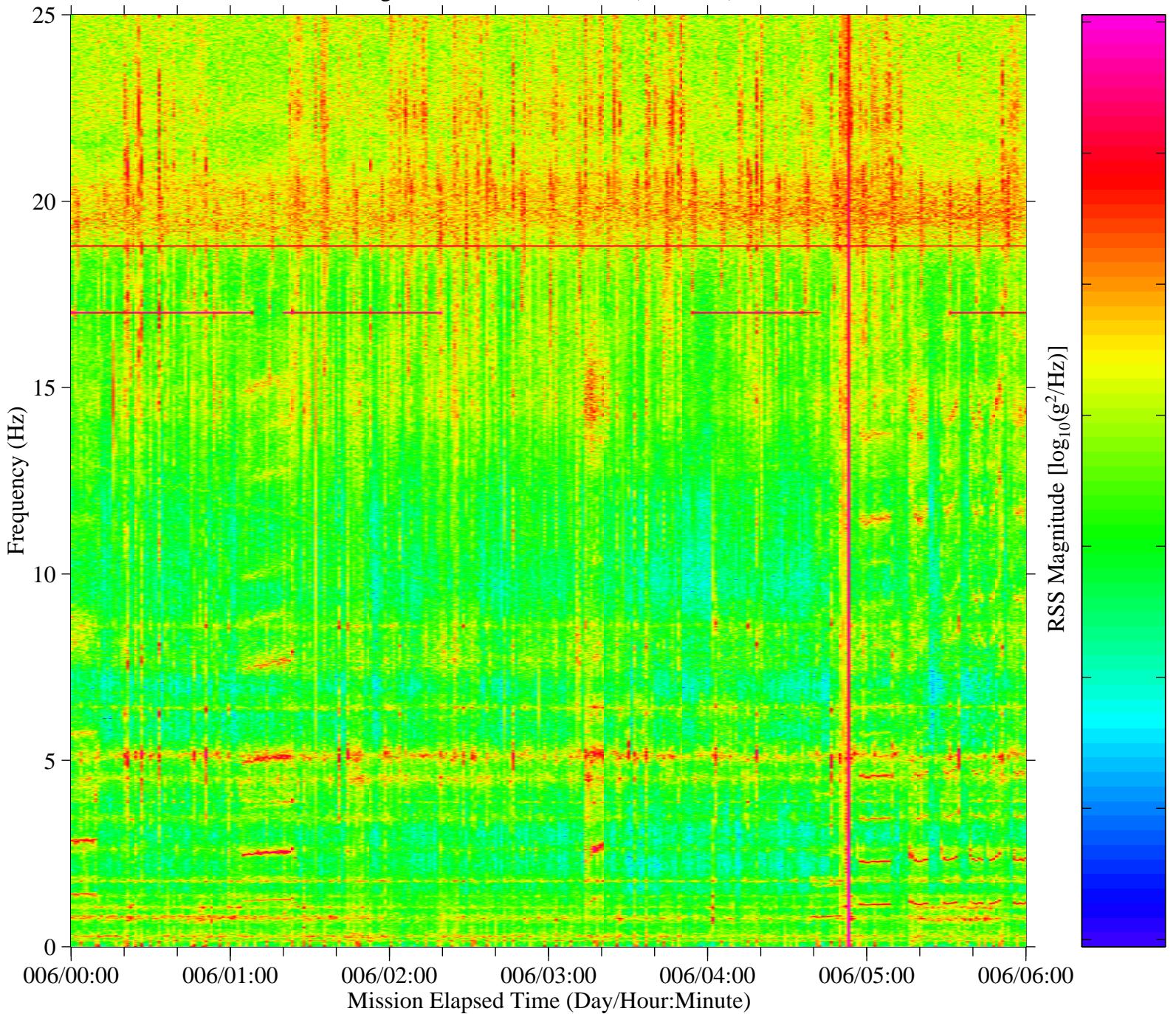


Figure 45a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

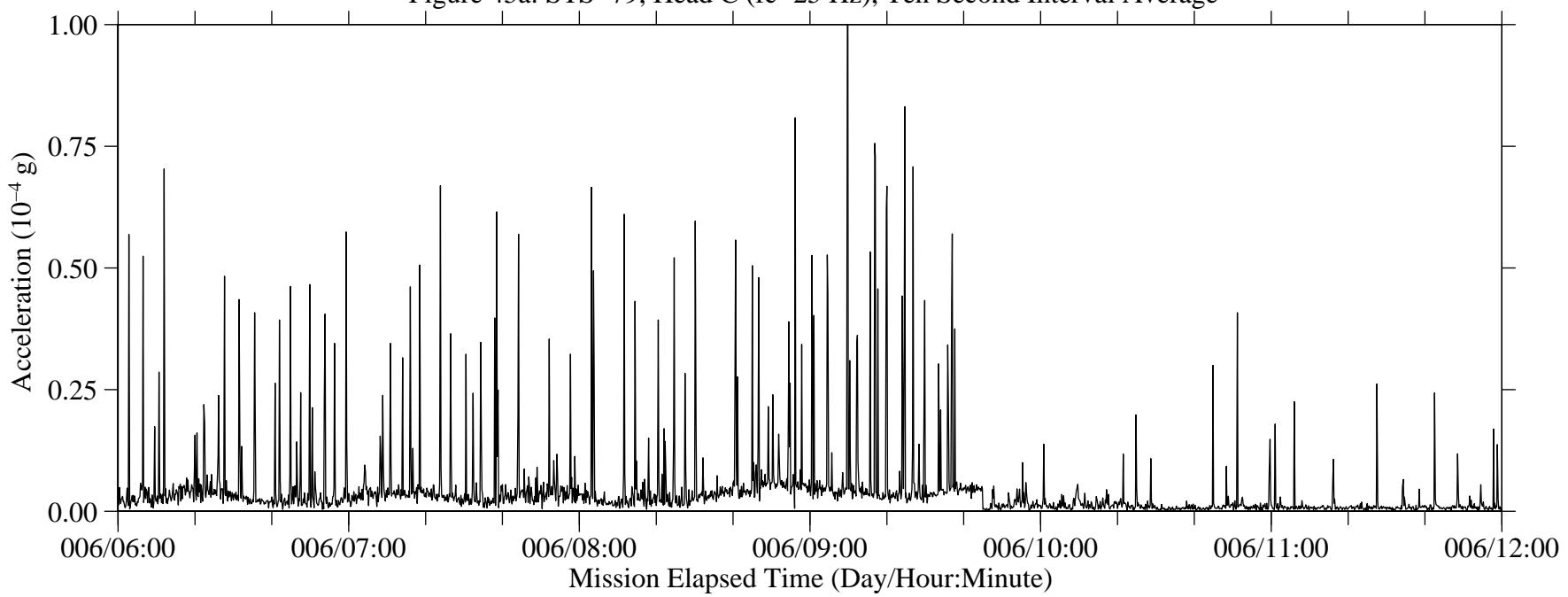


Figure 45b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

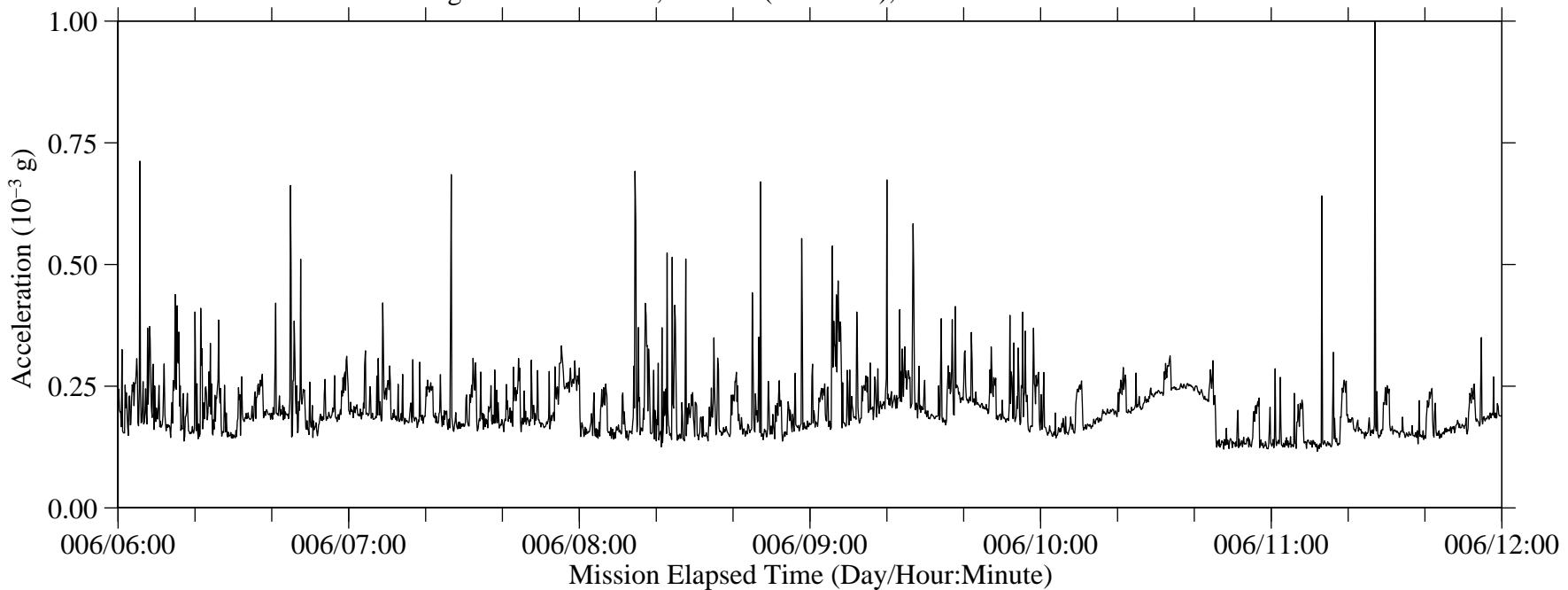
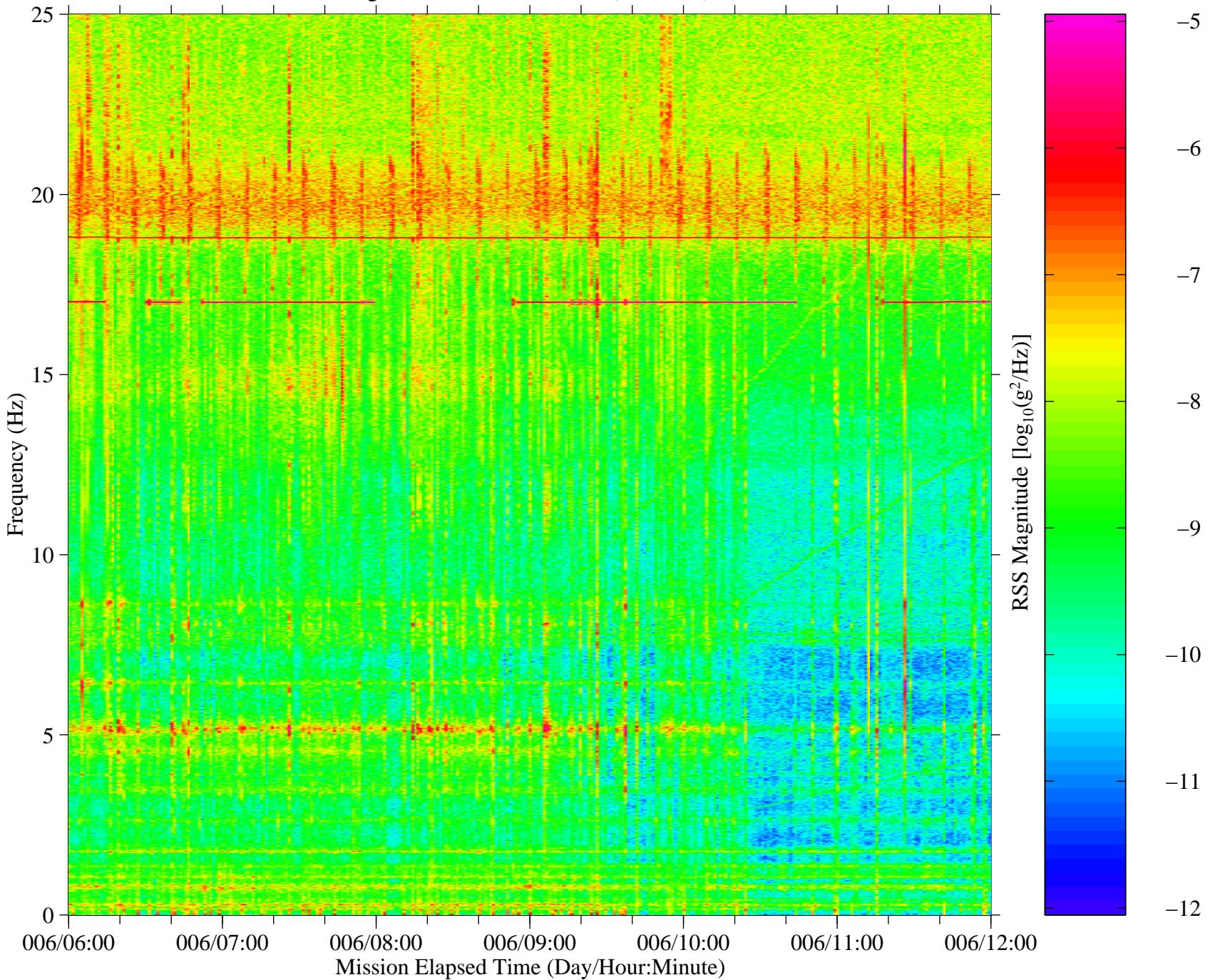


Figure 46: STS-79, Head C (fc=25 Hz)



B-49

Figure 47a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

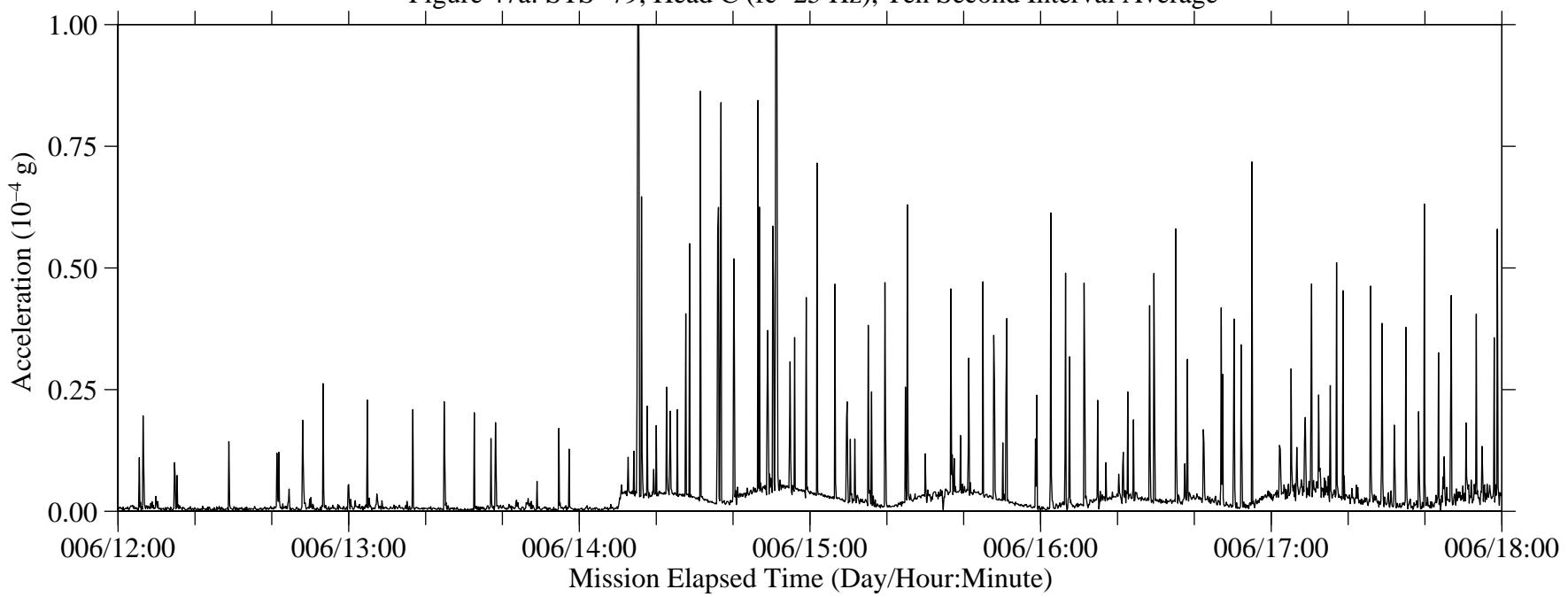


Figure 47b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

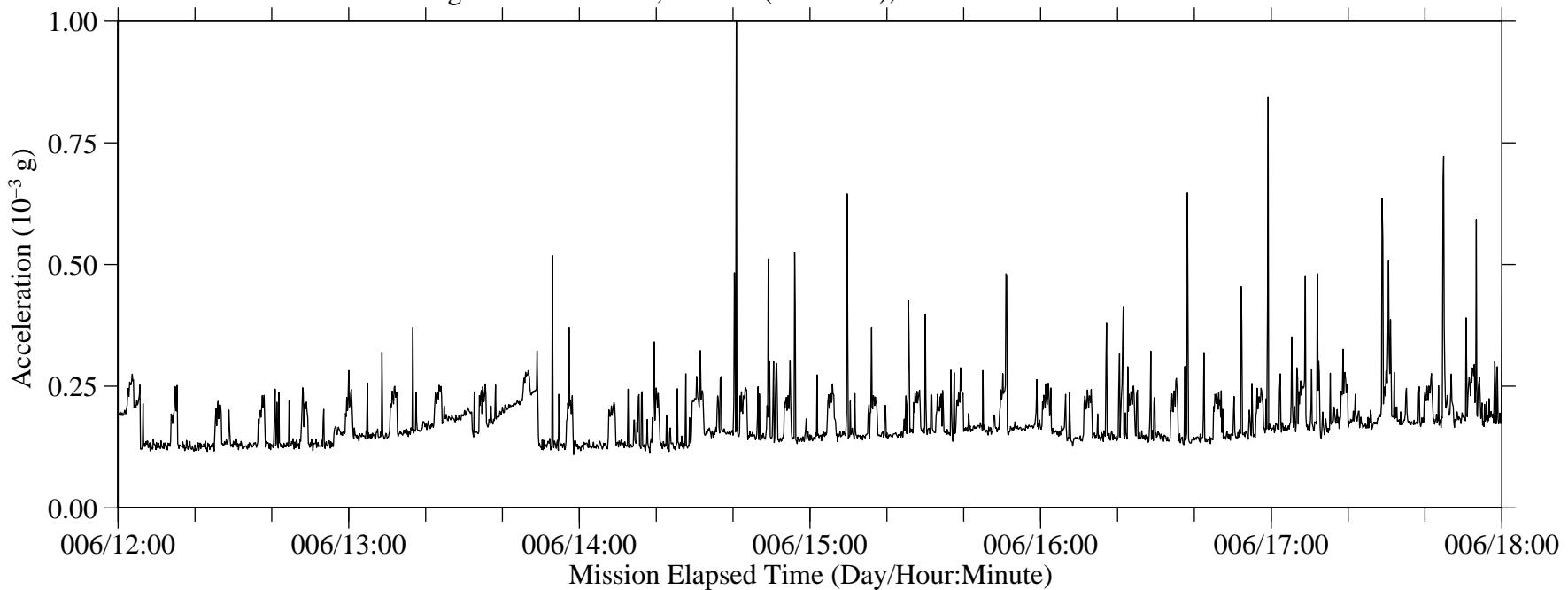


Figure 48: STS-79, Head C (fc=25 Hz)

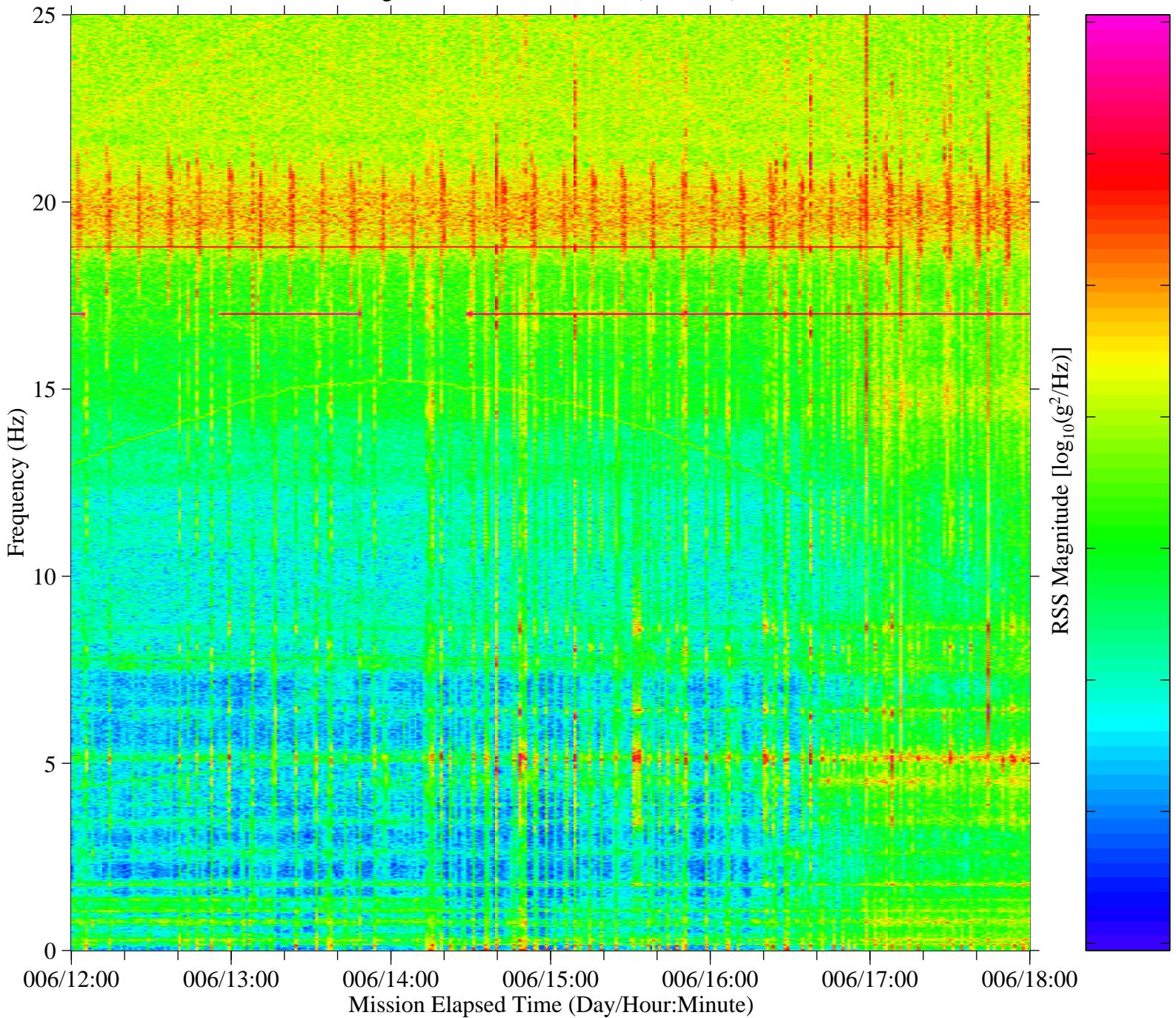


Figure 49a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

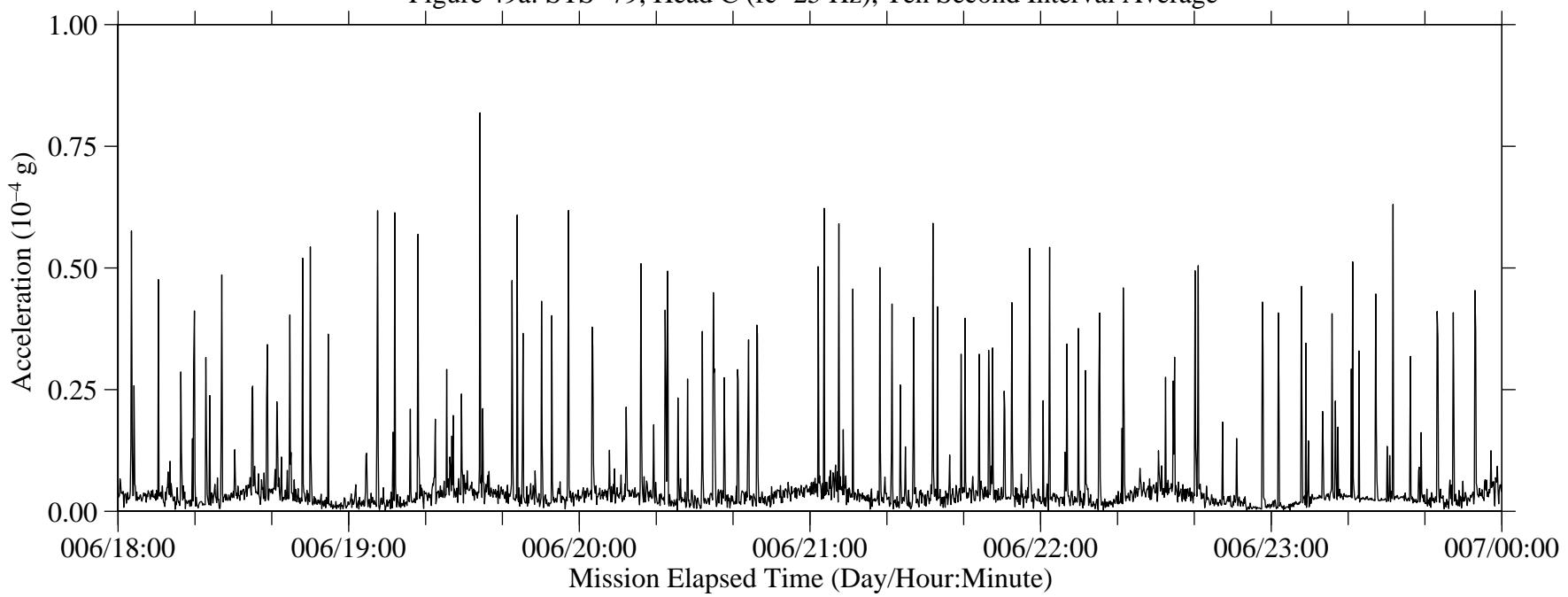
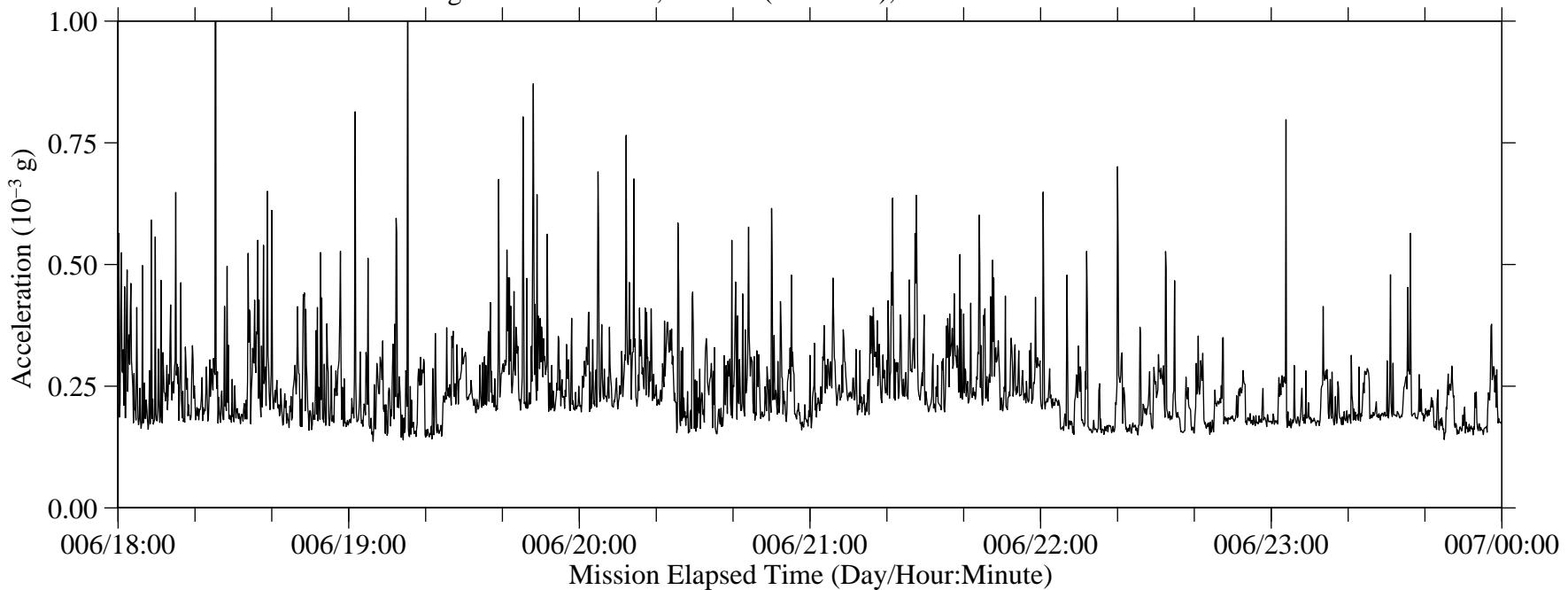


Figure 49b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS



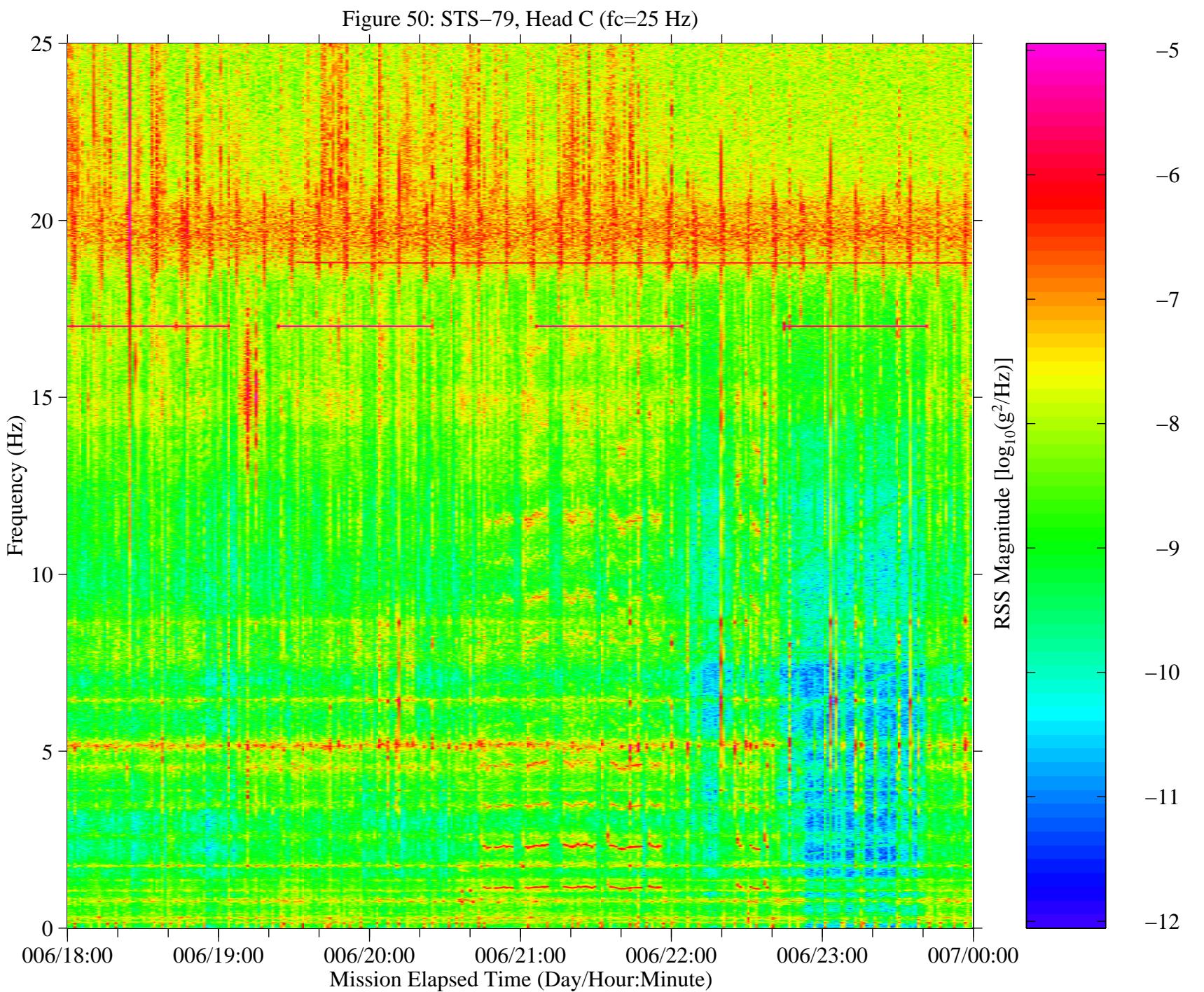


Figure 51a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

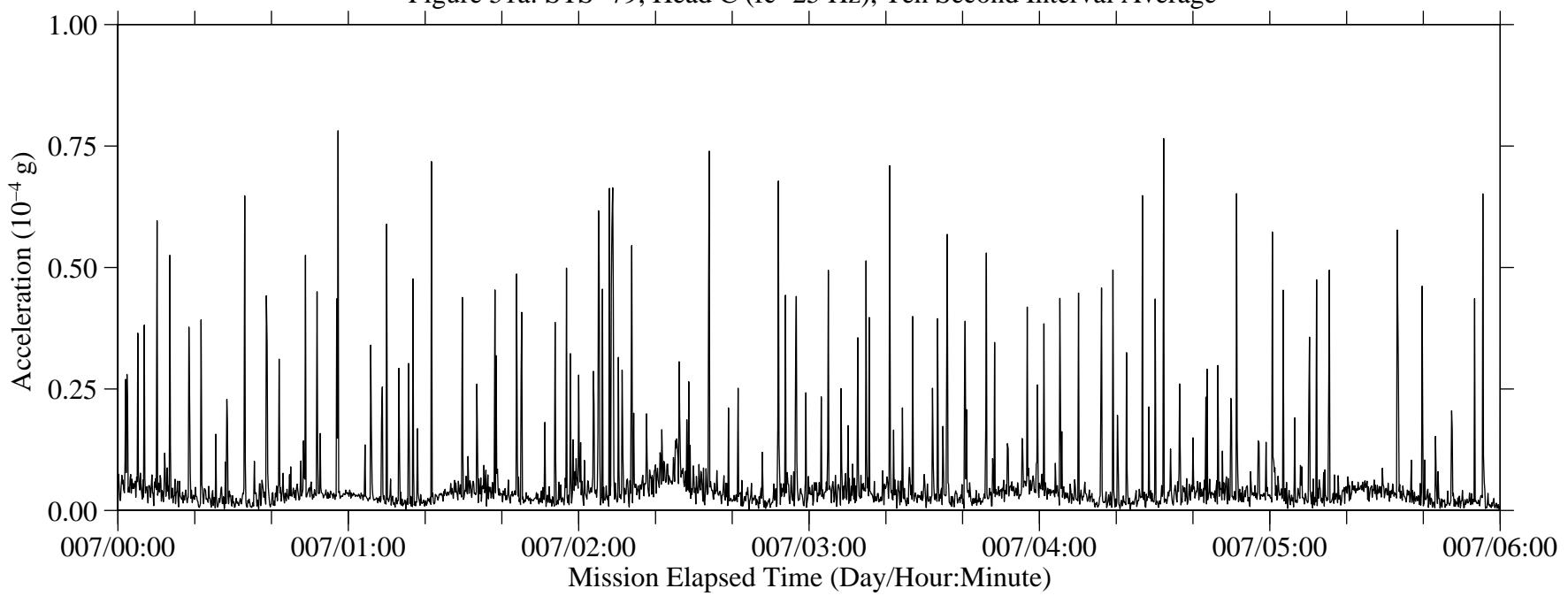


Figure 51b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

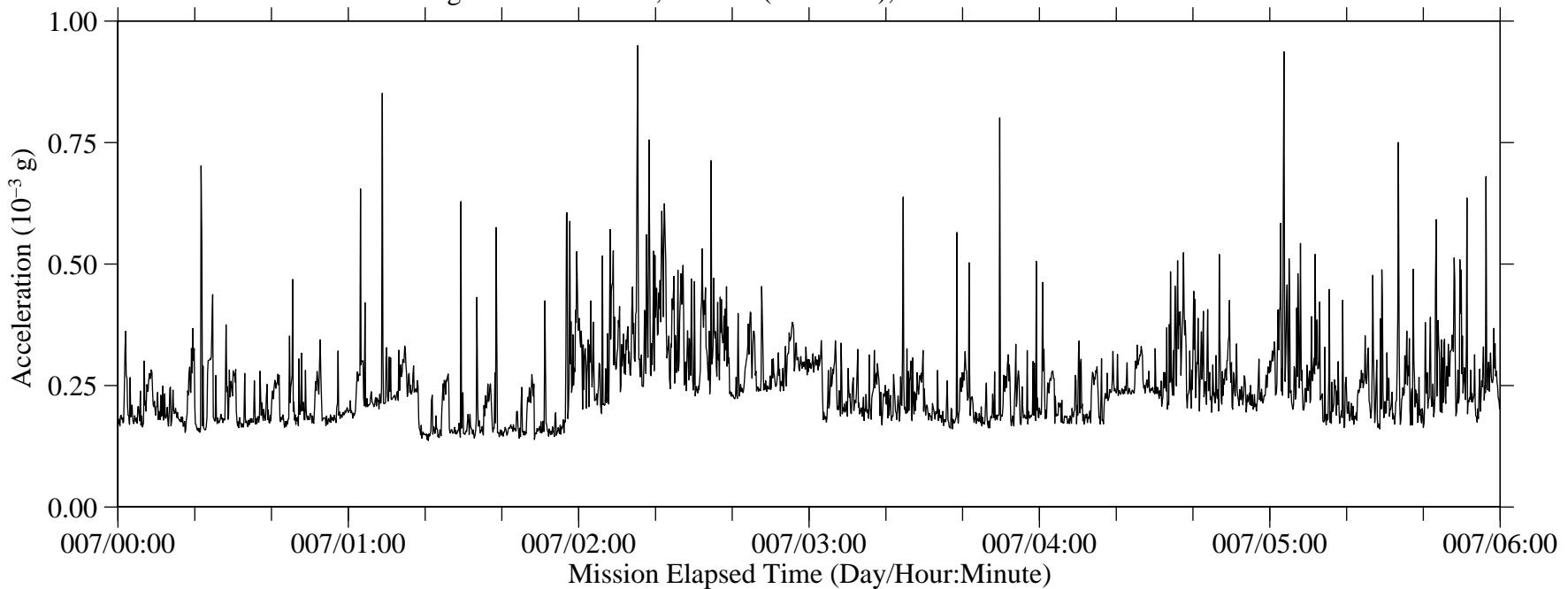


Figure 52: STS-79, Head C (fc=25 Hz)

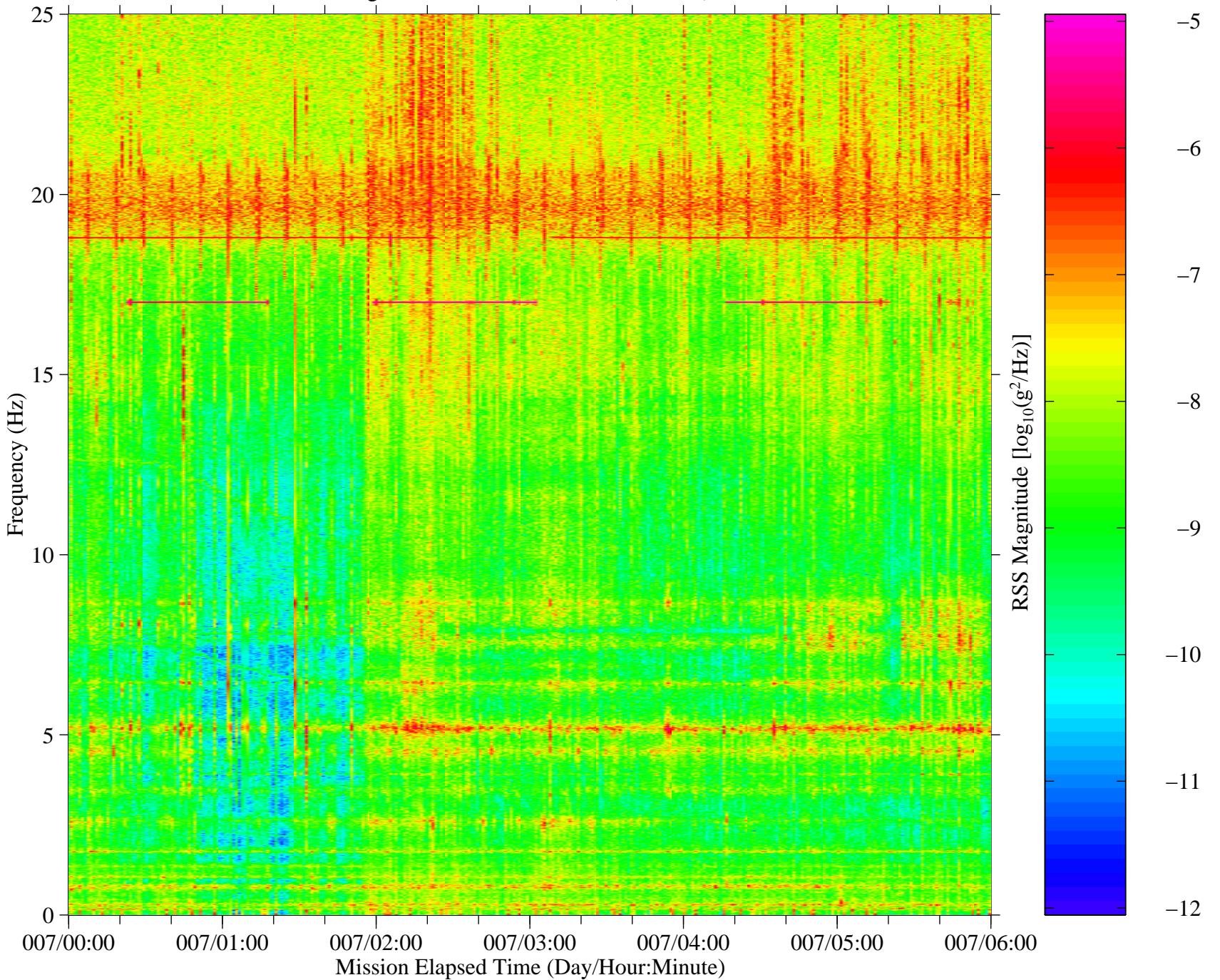
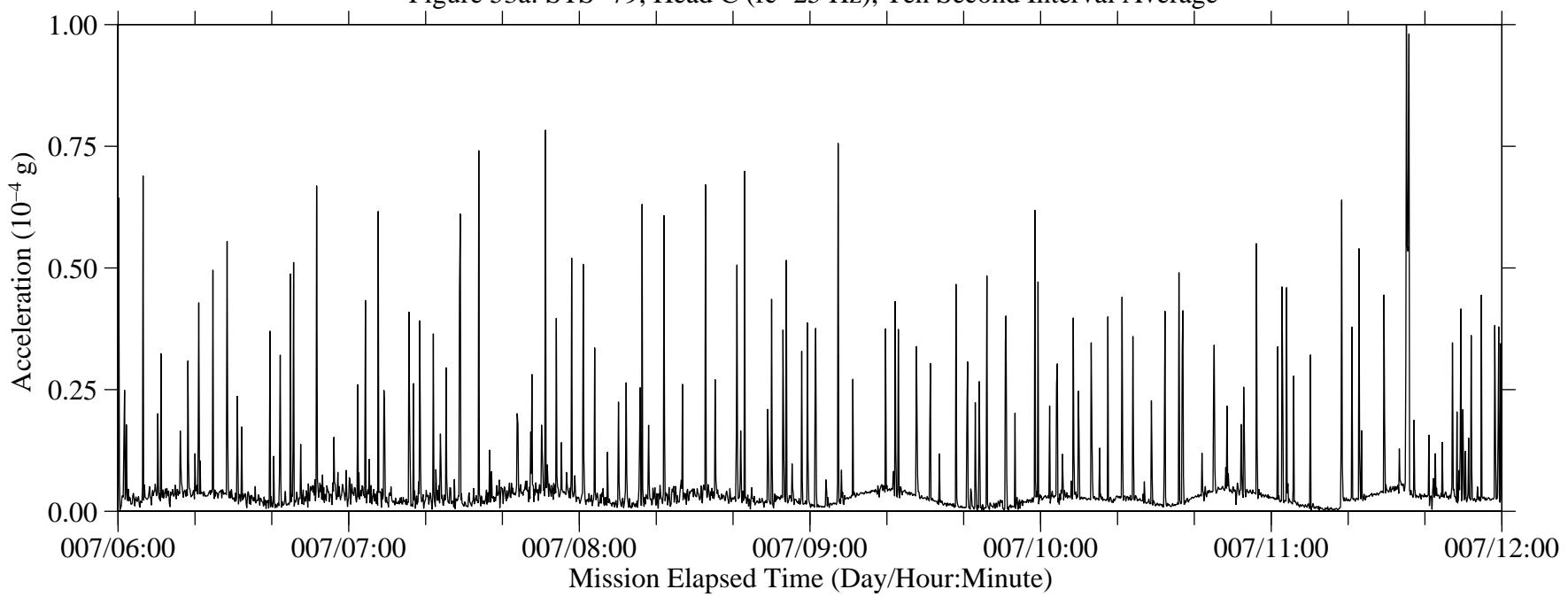


Figure 53a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-56

Figure 53b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

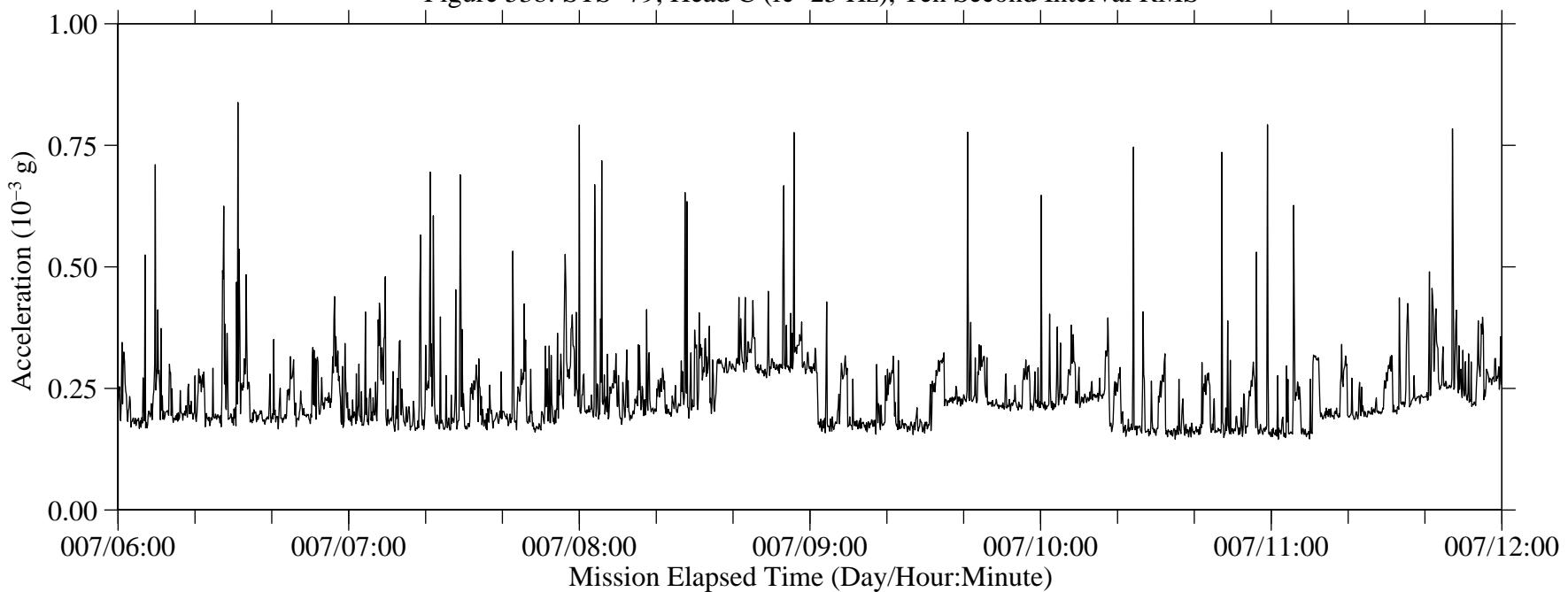


Figure 54: STS-79, Head C (fc=25 Hz)

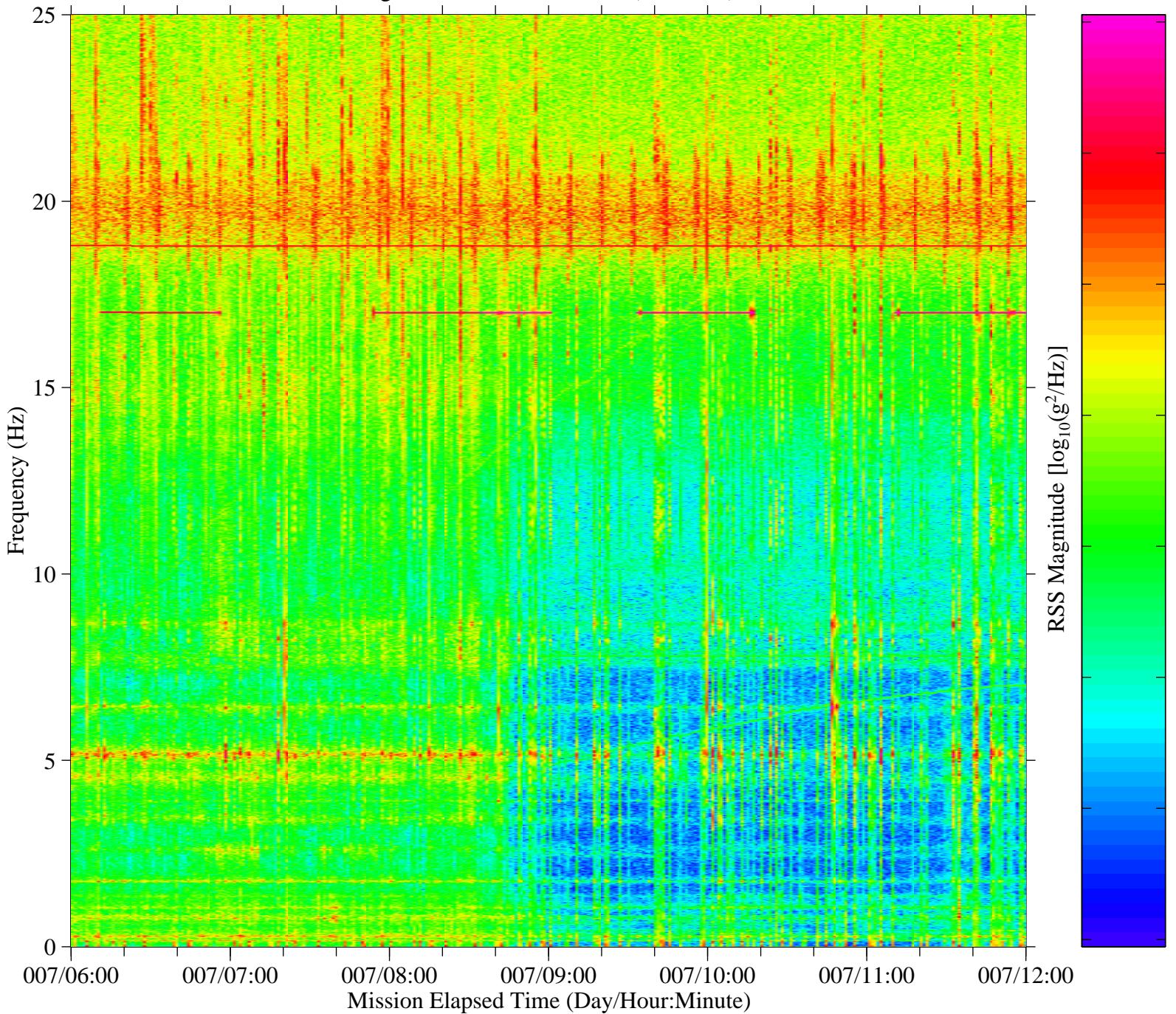


Figure 55a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

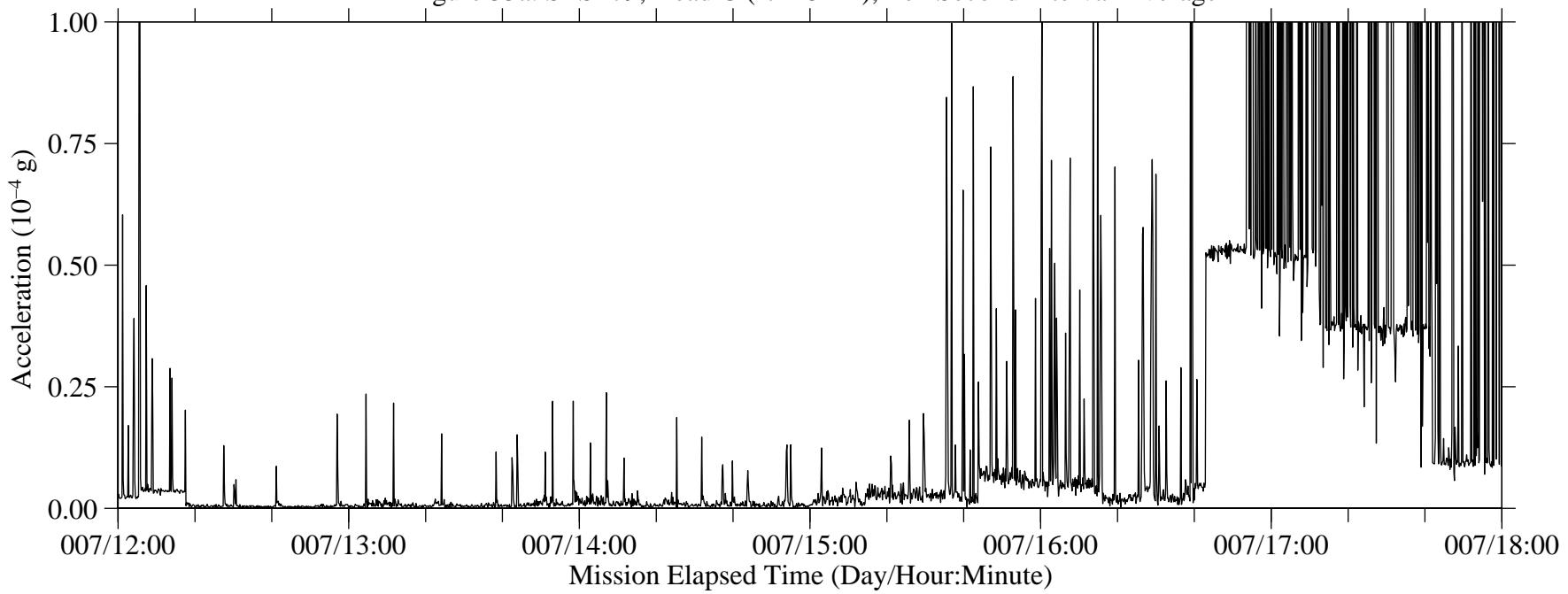


Figure 55b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

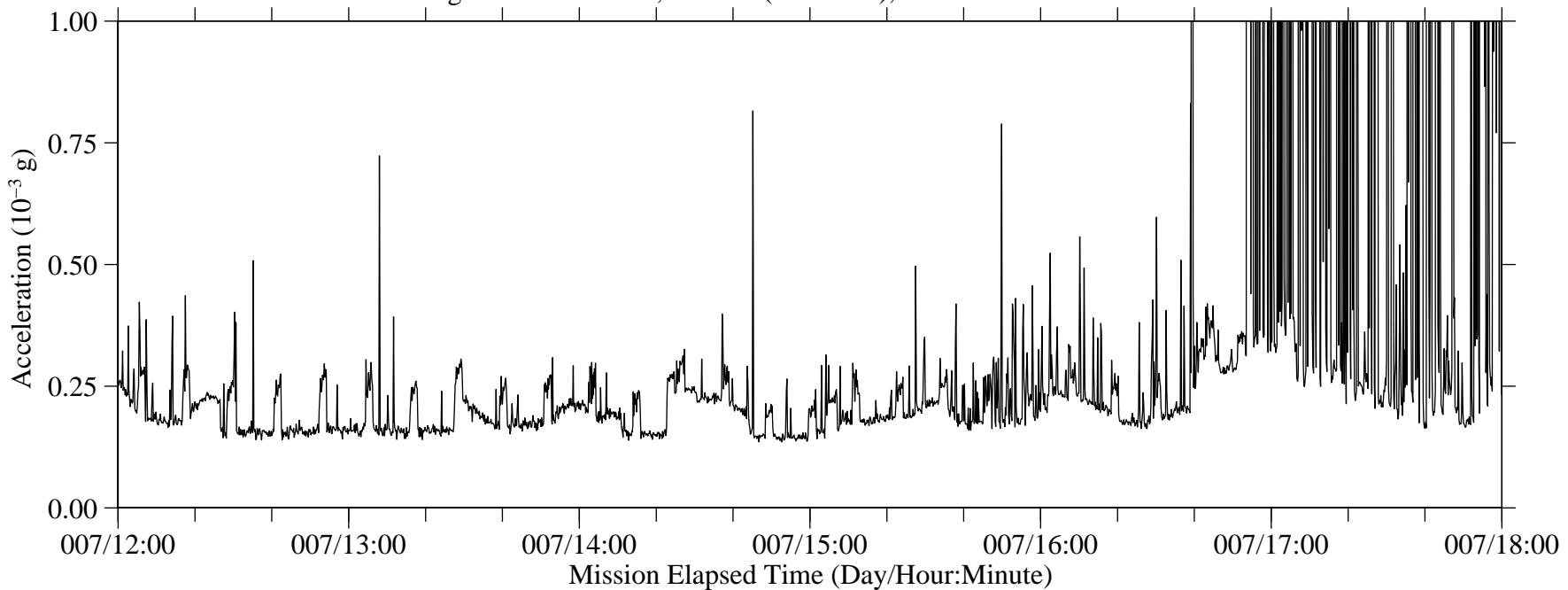


Figure 56: STS-79, Head C (fc=25 Hz)

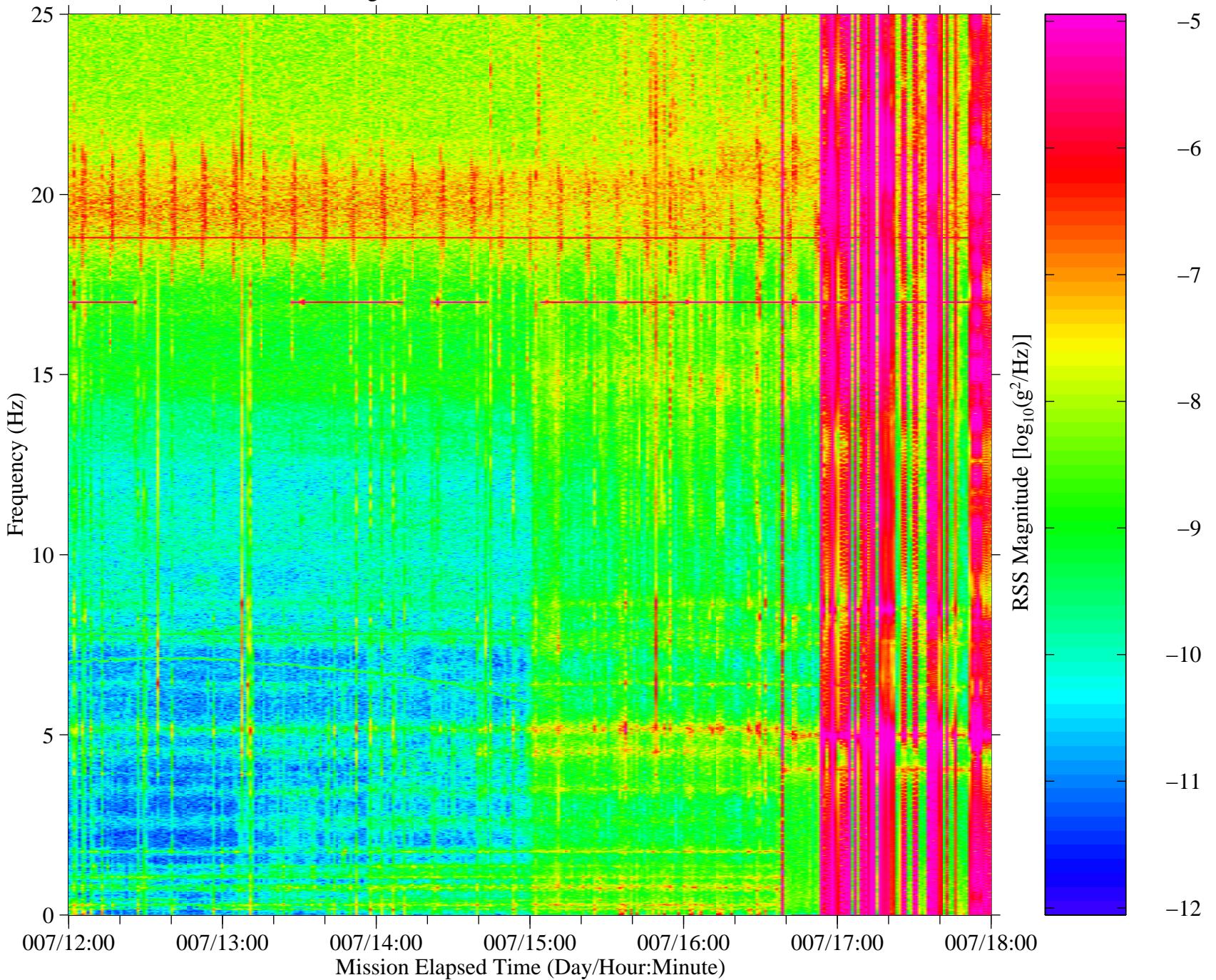


Figure 57a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

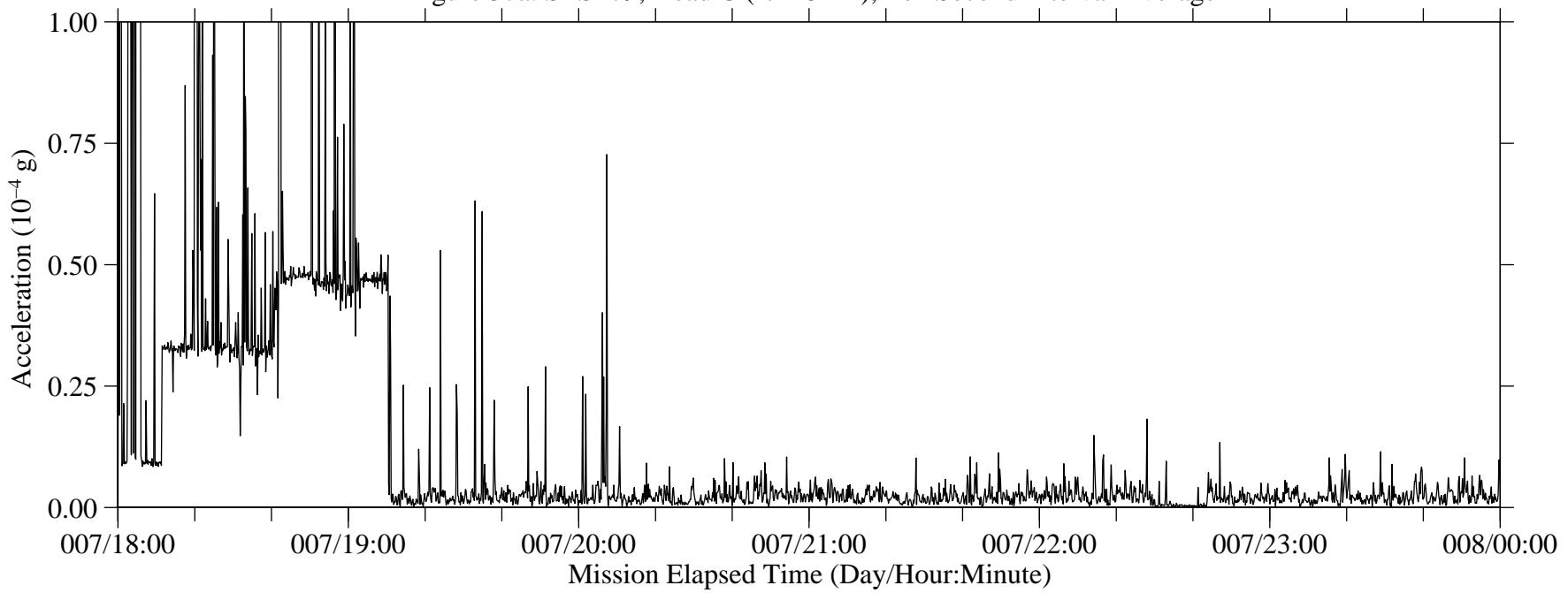
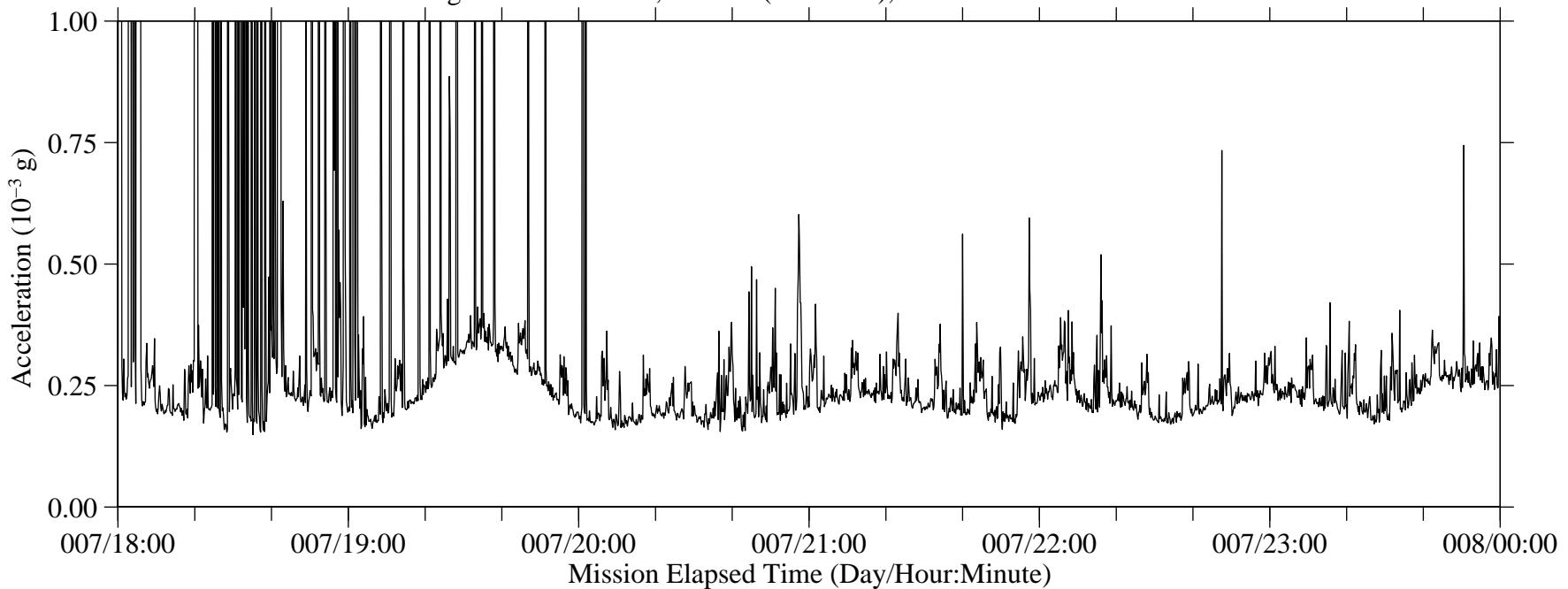


Figure 57b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS



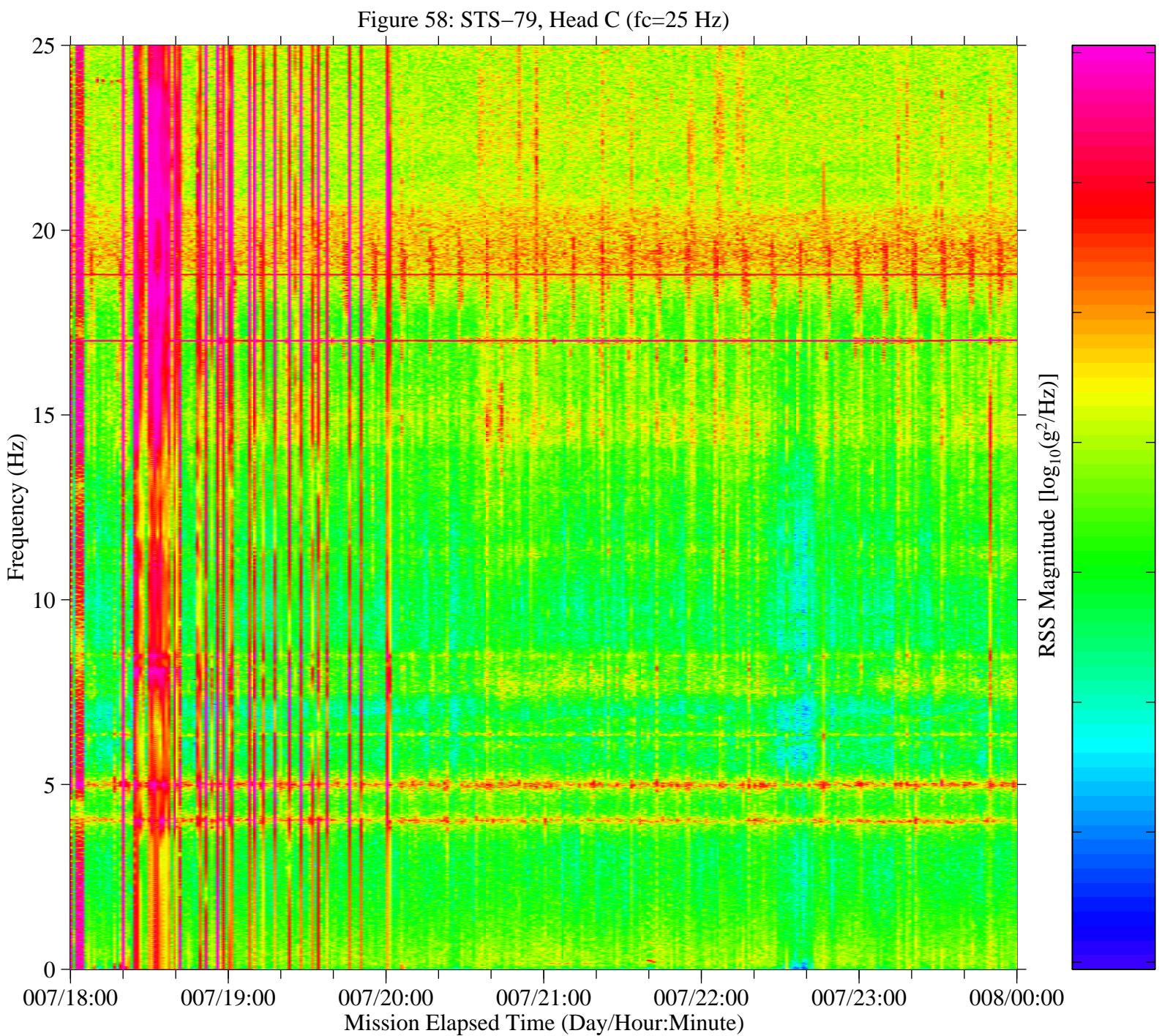


Figure 59a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

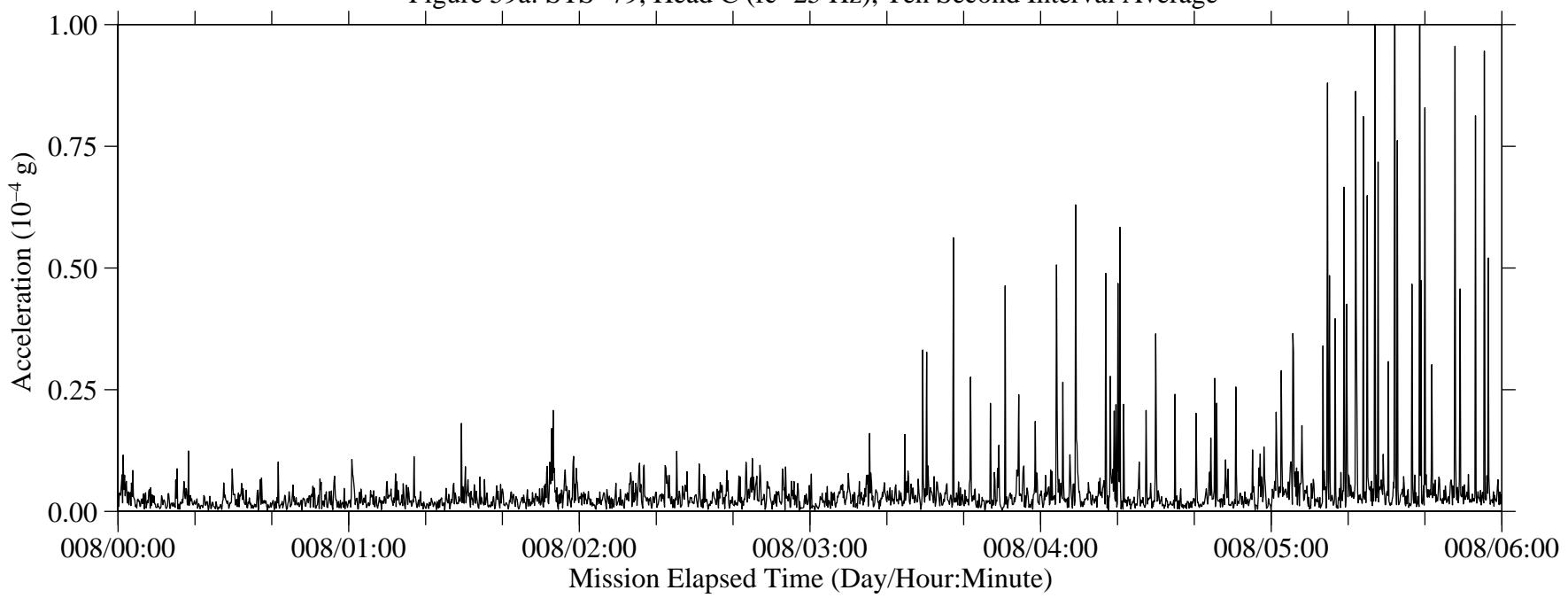


Figure 59b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

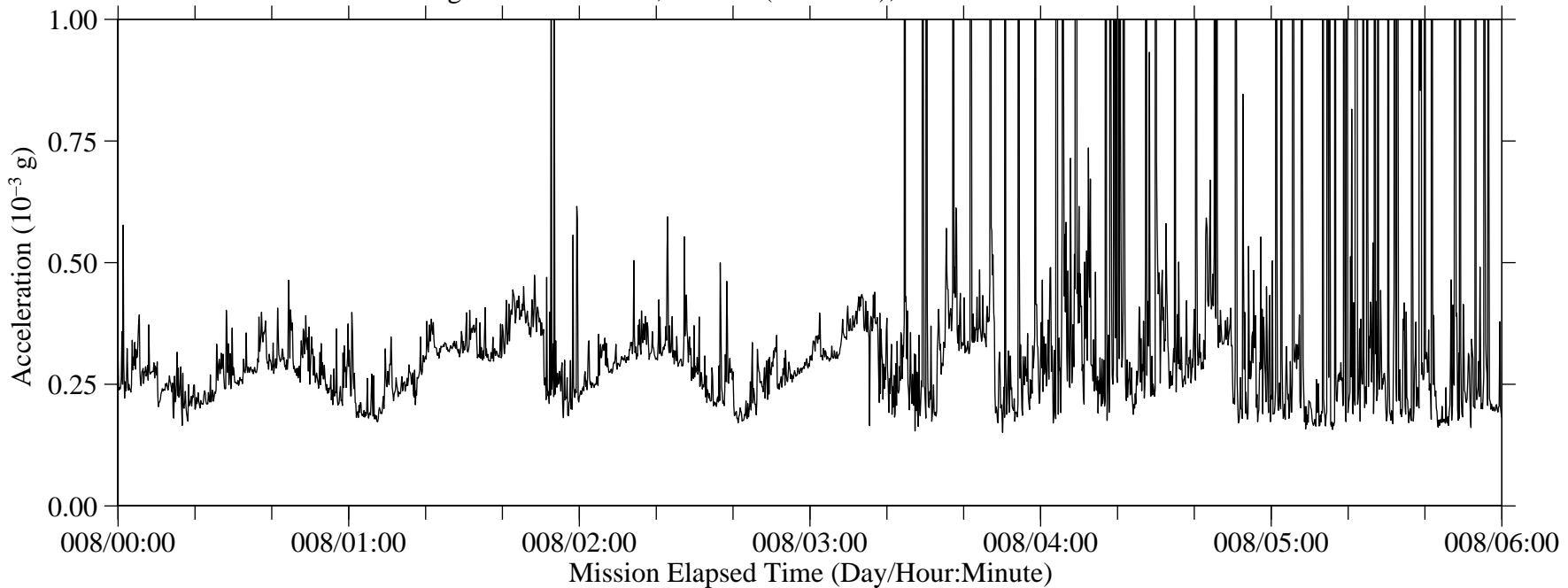


Figure 60: STS-79, Head C (fc=25 Hz)

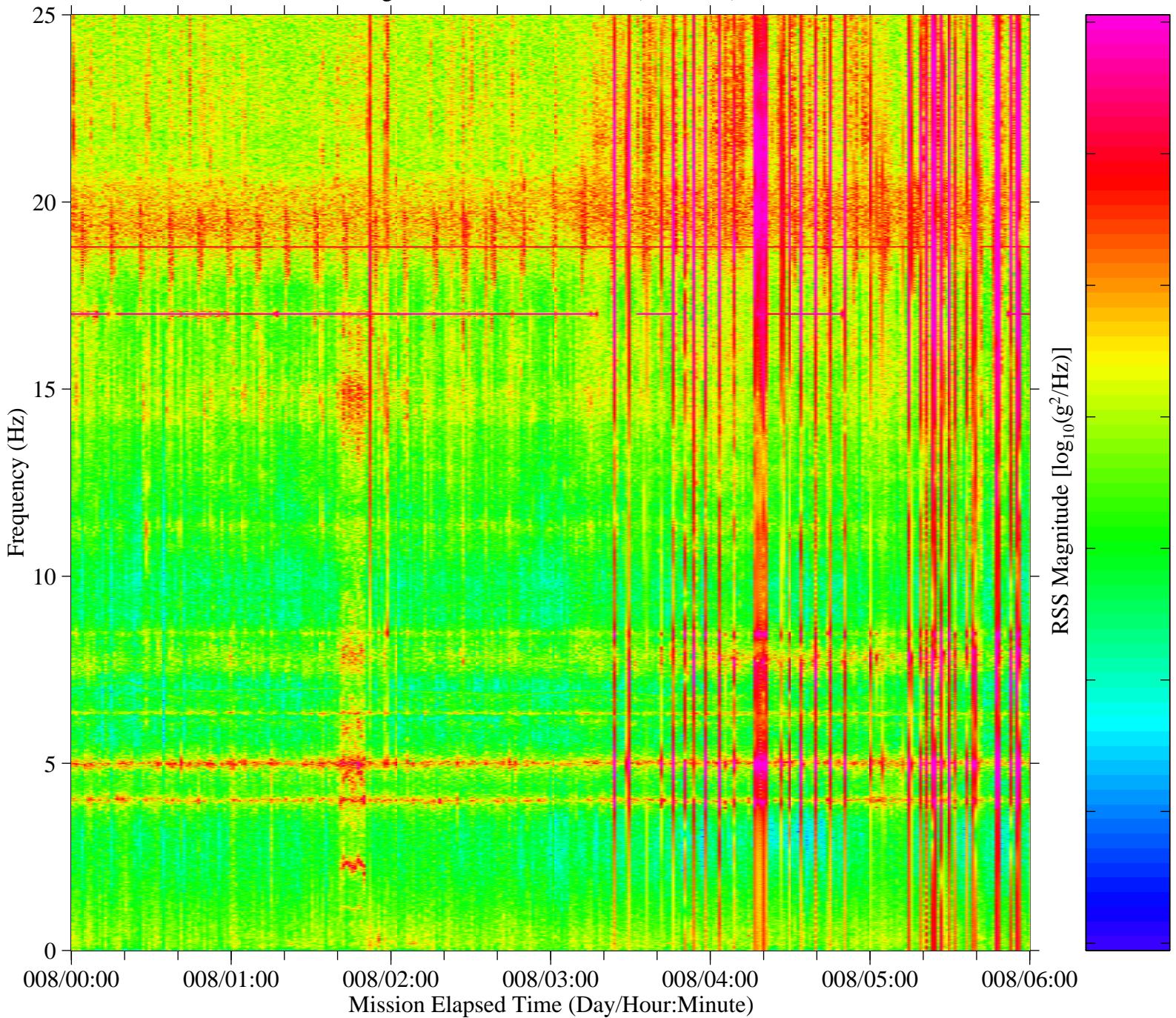
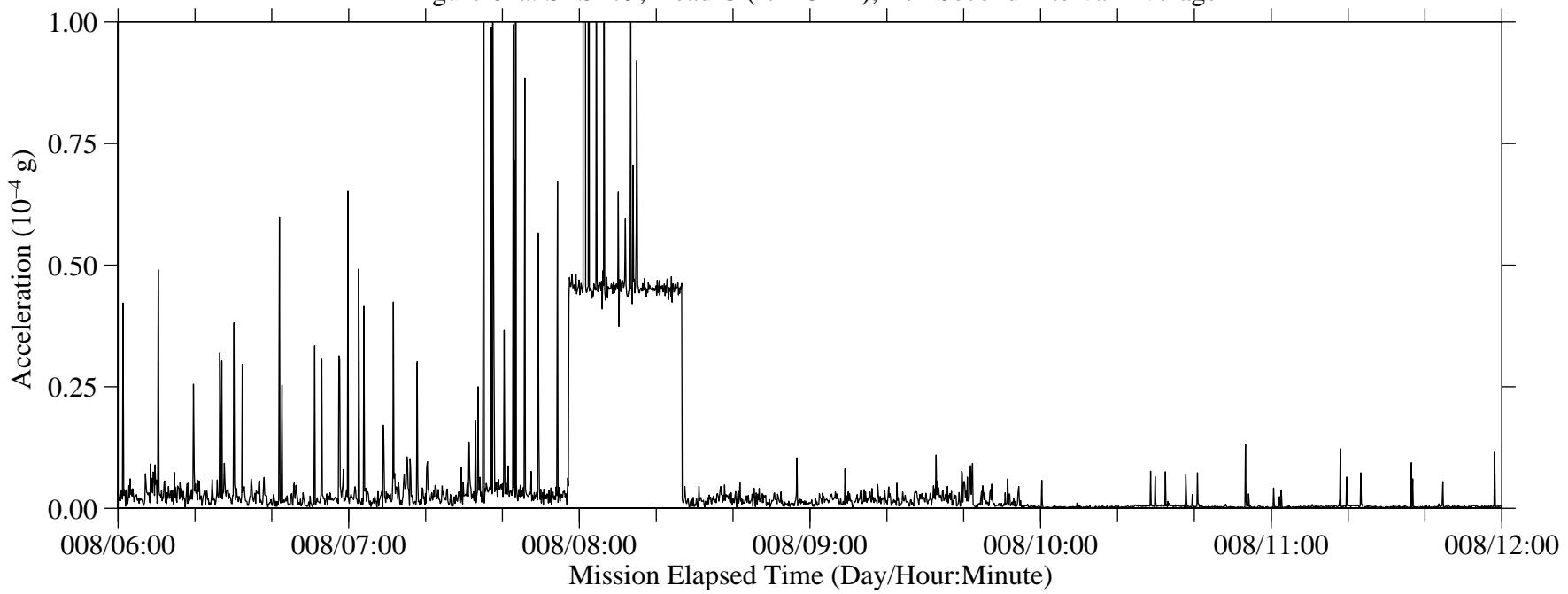


Figure 61a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average



B-64

Figure 61b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

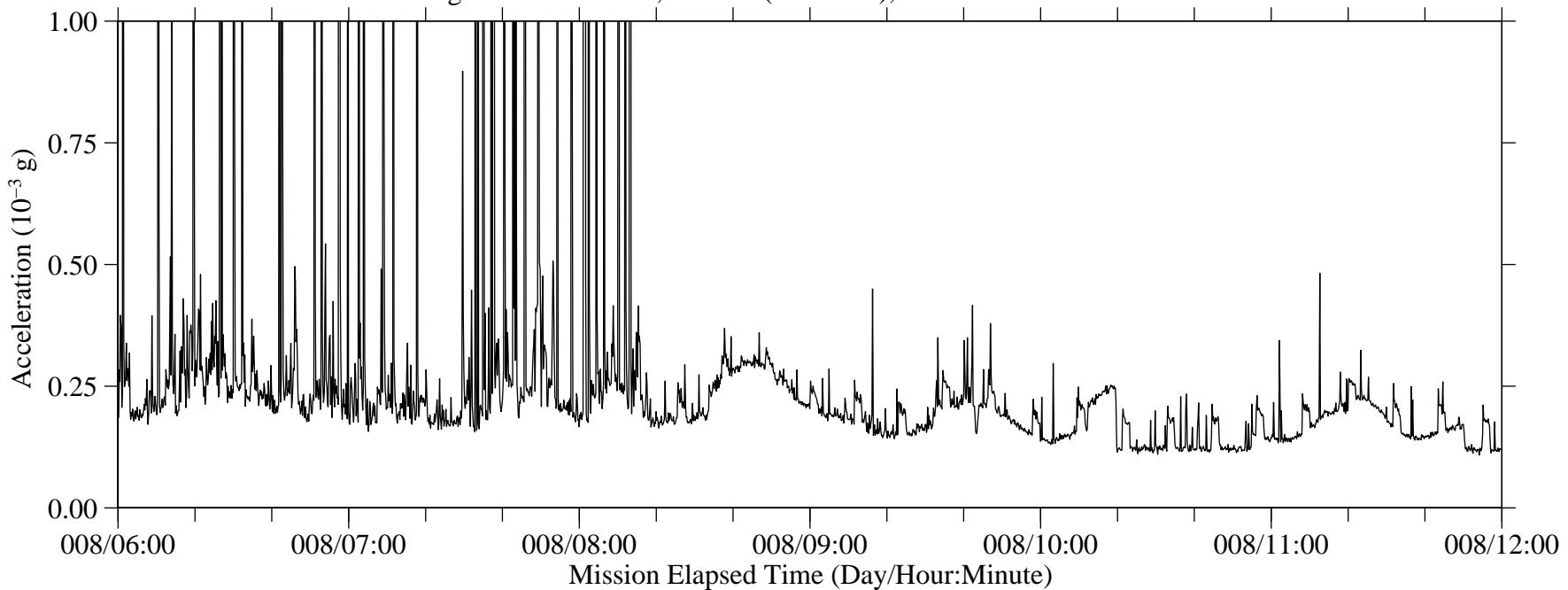


Figure 62: STS-79, Head C (fc=25 Hz)

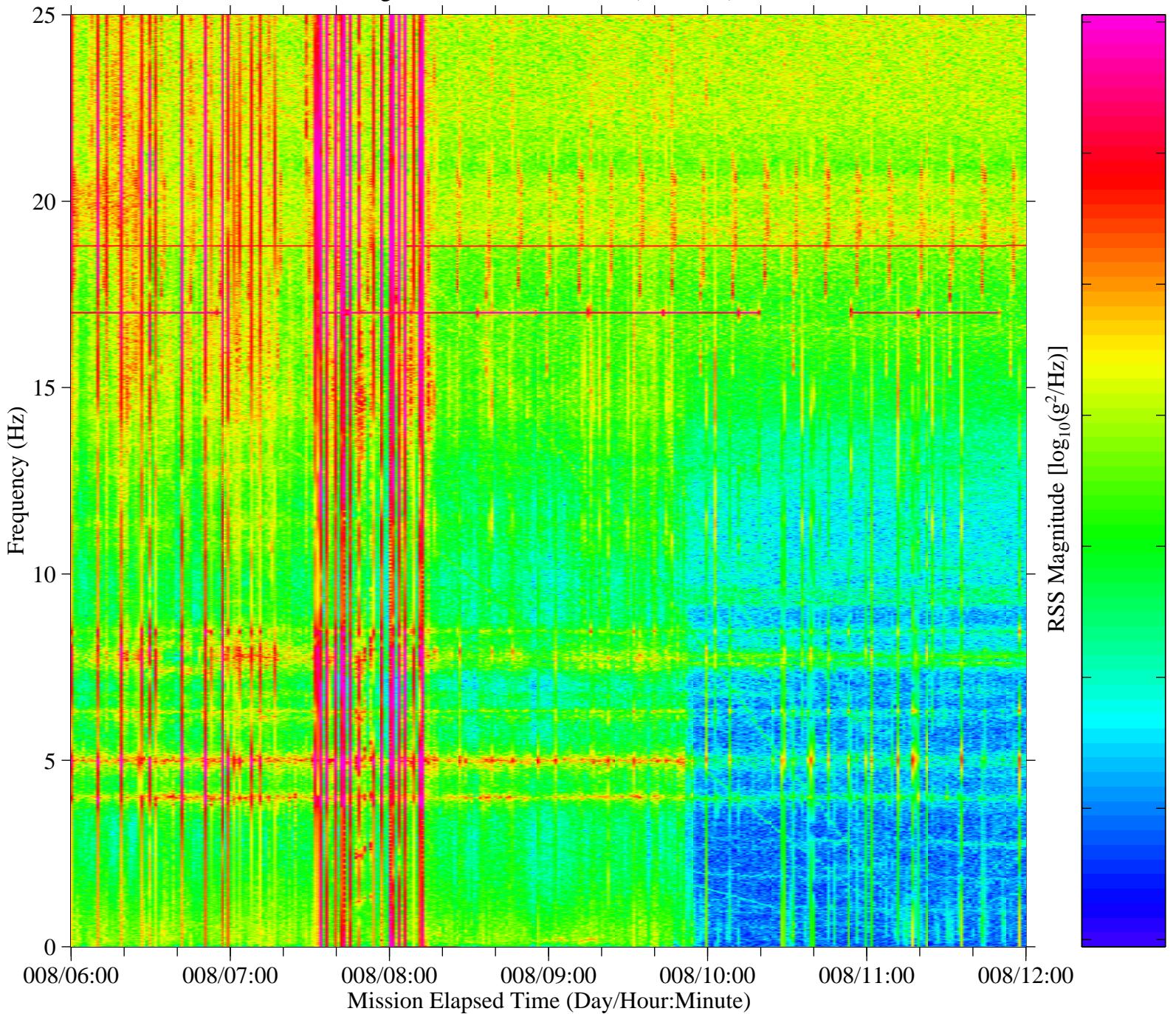


Figure 63a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

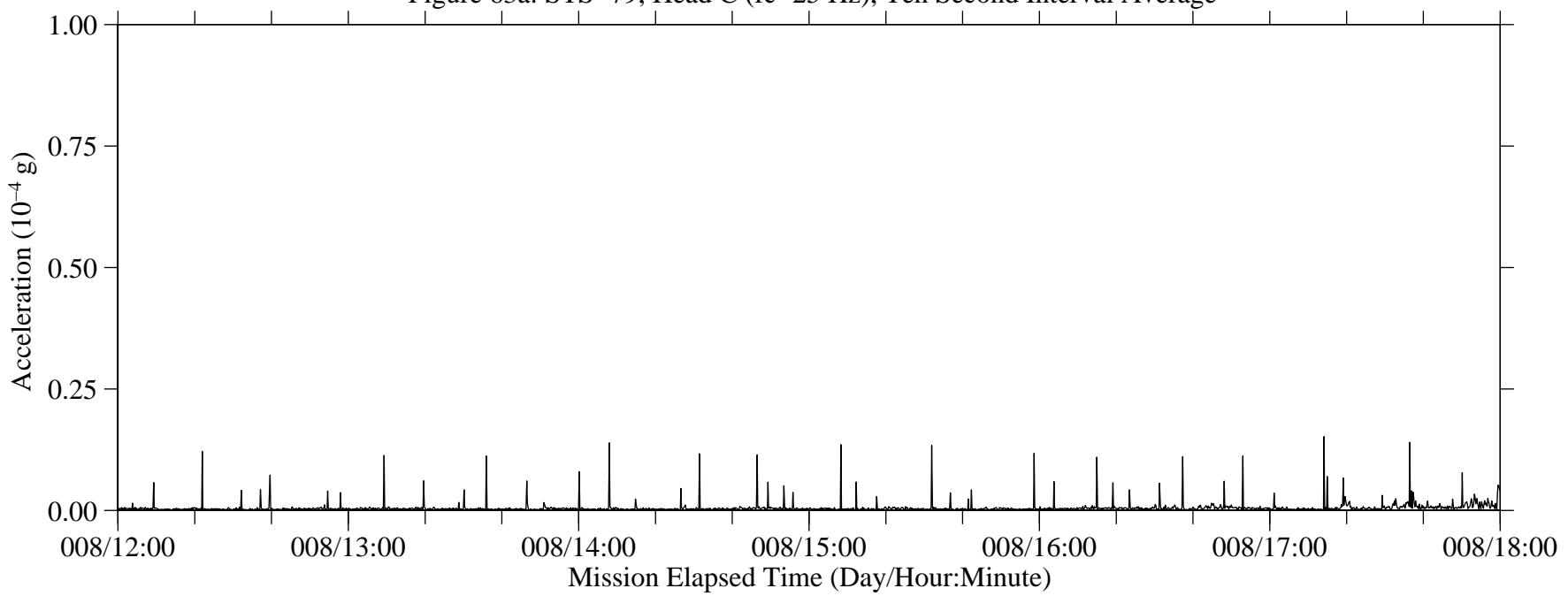


Figure 63b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

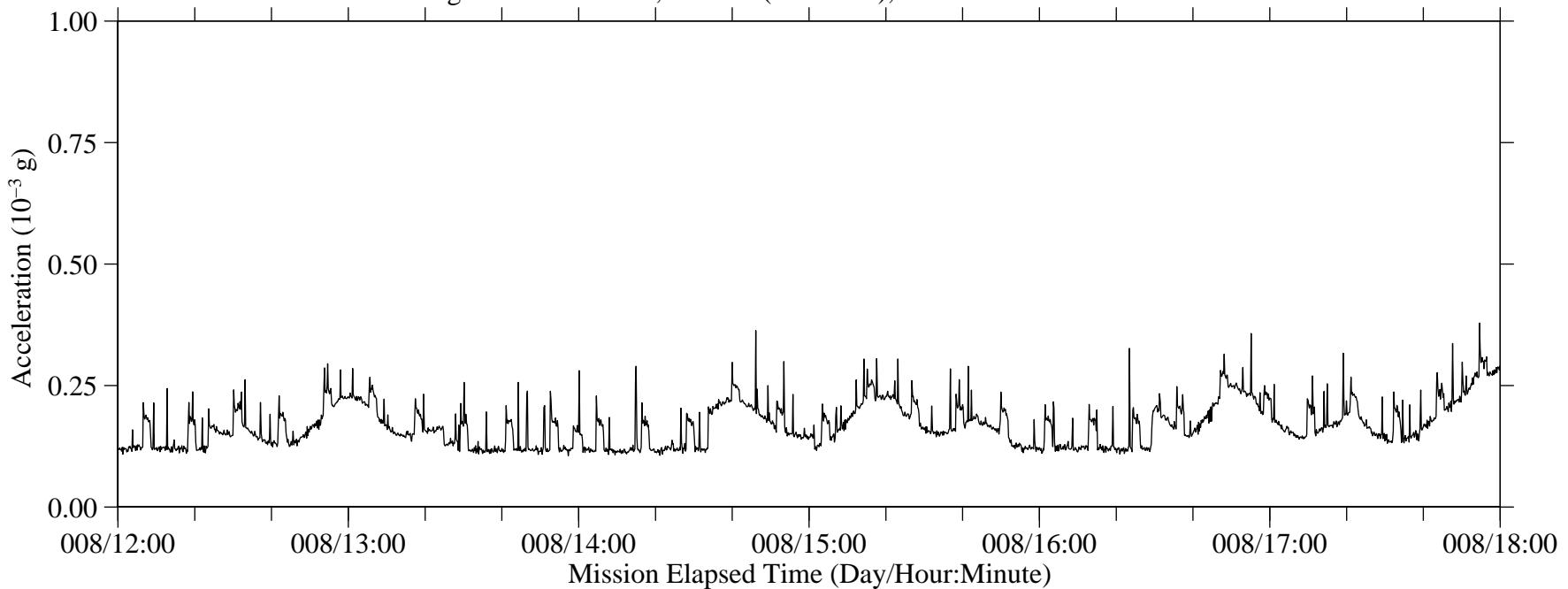
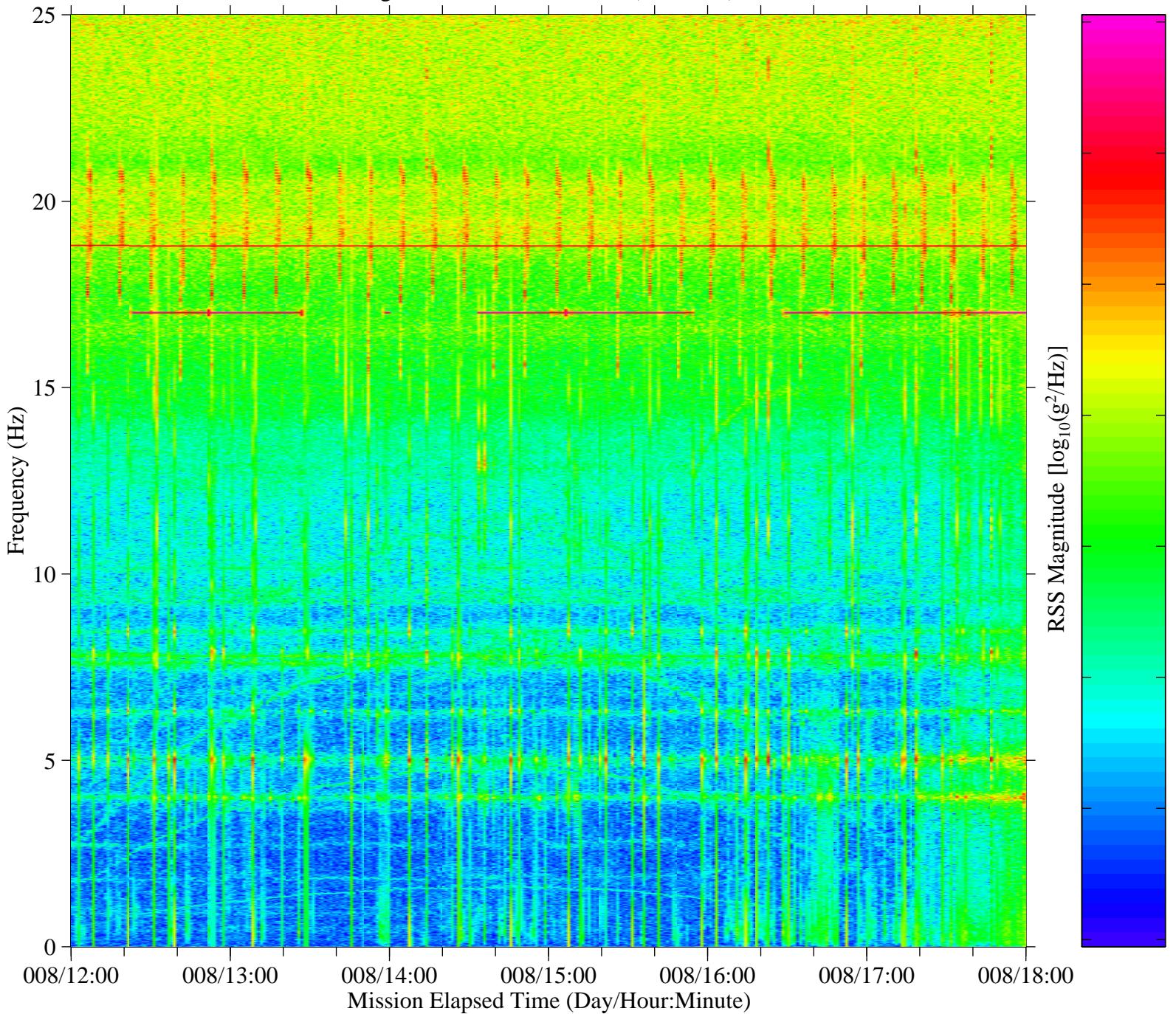


Figure 64: STS-79, Head C (fc=25 Hz)



B-67

Figure 65a: STS-79, Head C (fc=25 Hz), Ten Second Interval Average

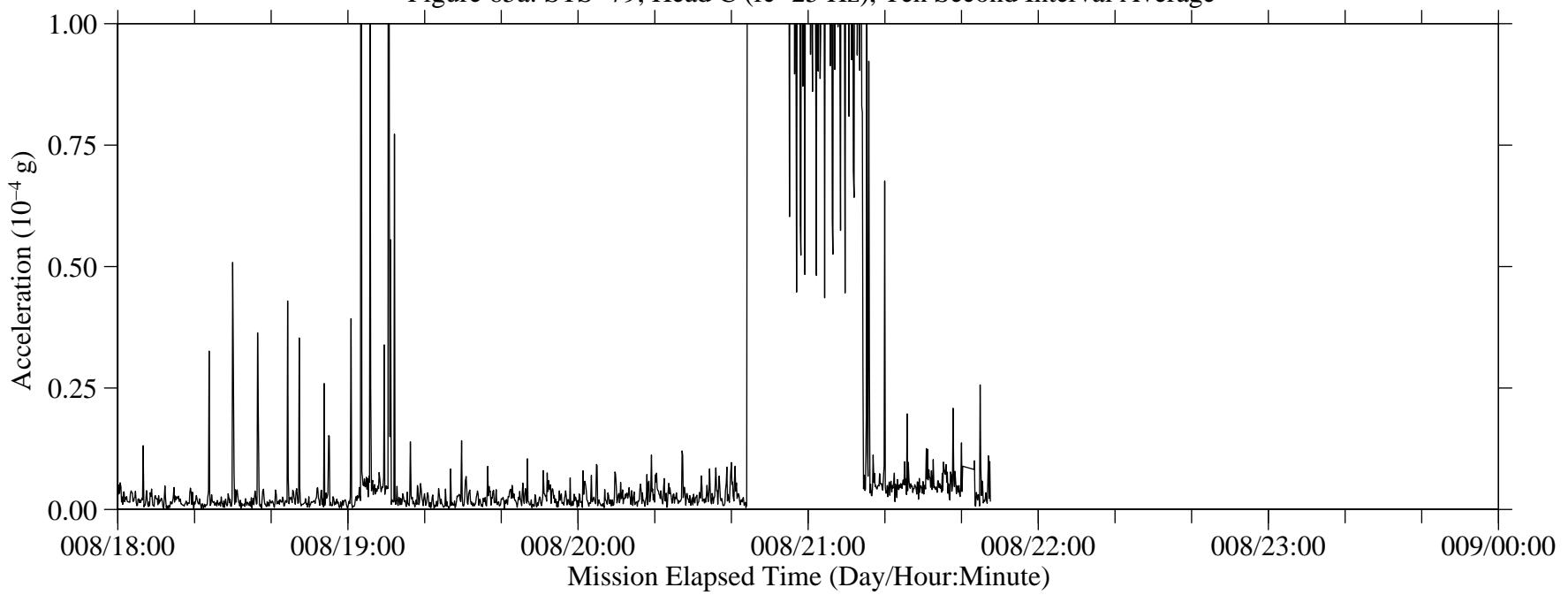


Figure 65b: STS-79, Head C (fc=25 Hz), Ten Second Interval RMS

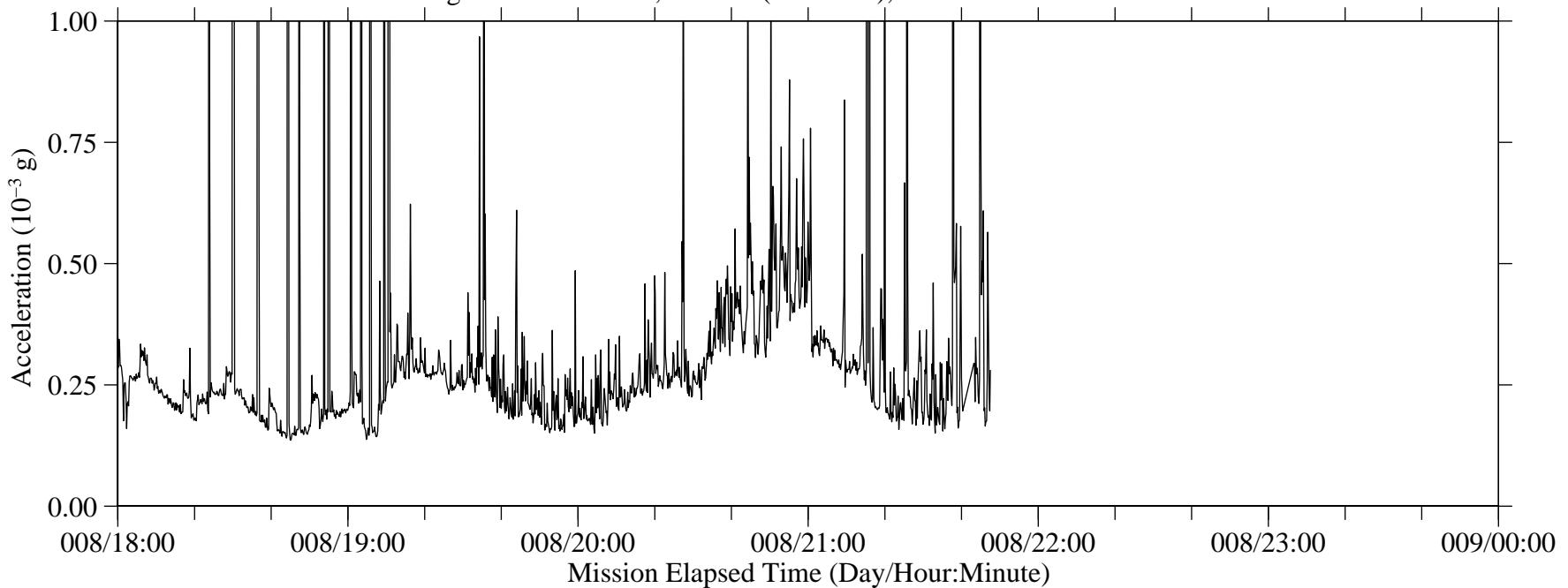


Figure 66: STS-79, Head C (fc=25 Hz)

